SPECIAL METHOD IN SCIENCE

McMURRY

SPECIAL METHOD

...IN....

NATURAL SCIENCE

FOR THE

FIRST FOUR GRADES

OF THE

COMMON SCHOOL.

THIRD EDITION.

...BY...

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AND

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PREFACE.

THIS is the fourth of a series of Special Methods in the common school studies, and is designed to be a direct help to teachers in recitation work. The plan is to give a broad view of the problem of science teaching by a brief historical and critical survey of science teaching, and of the ideas thus far developed in schools.

One of the great difficulties is to find some basis for selecting and arranging the most important and suitable topics for a course of study when the field of science furnishes such a vast and varied collection of materials.

The method of treating science topics in these grades is treated at some length.

Although natural science instruction is fundamentally based upon direct observation, the best books are found extremely helpful to teachers. A list of about a hundred and fifty books, somewhat carefully selected and classified, is presented for the help of teachers, and the publishers are named with addresses.

A large number of topics for first and second grade, worked out and used by Mrs. Lida B. McMurry in primary classes, is given in the full treatment.

The plan for third and fourth grades has been worked out and more fully illustrated by examples in this second edition of the book.

It is the purpose of the author to work out in a separate volume a course of study in Natural Science for the last four grades of the common school (5th to 8th grade inclusive).

The other works of this series are:

Special Method in *Literature and History*, especially the oral treatment of stories in primary and intermediate grades. The history course for grammar grades is also discussed and outlined.

Special Method in *Reading*, a discussion of the quality, culture-value, and method of using the best classics as reading exercises. A full list of one hundred and forty-six choice books, arranged according to grades, is given.

Special Method in *Geography*, a plan of geography lessons for third and fourth grades. It deals with the selection and method of important types. The material for thirteen of these type studies of the Mississippi Valley is given in full.

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September 30, 1898.

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INTRODUCTORY DISCUSSION.

FOR AT least three centuries there has been abundant discourse among writers on education in favor of natural science study in the schools. Educational reformers like Comenius, Rousseau, and Colonel Parker have laid great stress upon the educative value in childhood and youth of the contact between mind and matter in the forms which nature presents. School education has always been too bookish, too much separated from objects and realities of experience.

Comenius found education in his day mired in Latin forms, technicalities, and abstractions. It was a killing process to try to awaken childlike interests and mind action upon the dead rules and inflections of a purely formal grammar. By means of his Orbis Pictus and other books of method he tried to infuse some degree of interest and meaning into the lifeless drills of the schools. But it was an almost hopeless task so long as Latin remained, like a vast breastwork of obstruction, at the very doorway of education. It was impossible to establish a rational system of popular education so long as a dead language stretched its lifeless body across the threshold of school life, barring

entrance to the fields Elysian. But thanks to the power and vigor of our native tongue, it has taken at last the supreme place among languages in a child's education, and when he first enters school he is in possession of this treasure. The same thing has happened in France and Germany and in other European countries.

The vernacular has become the fundamental medium of thought. One of the enormities, therefore, that vexed the souls of children two or three hundred years ago has been swept away. But the linguistic and verbal spirit of the old régime is still with us, and many teachers still think children have the ideas when they have only conned the forms in which ideas are expressed. In the days of Latin supremacy, Comenius and the other reformers tried to save instruction from empty verbalism by associating the objects in nature with the Latin names, and we have been trying, for more than one generation, by means of object lessons and nature studies, to redeem education from the dry rot of verbal memorizing. But in our day we have already got beyond the idea that natural science is simply an auxiliary, a means of making language and other studies more significant and real. Nature study stands out in its own right, an equal among such studies as reading, mathematics, and language.

It is a matter of no little surprise with many that nature study has made so small progress in

the common schools. For three centuries in Europe and America there has been constant advocacy and boundless faith and enthusiasm in nature studies for children, but the output in the schools is close up to nothing. Yet a fuller appreciation of the inherent difficulties involved in a deep educational problem like this shows that centuries rather than years are required in working out such a problem. It may be truly said that a right selection of topics and a right teaching of natural science would produce a marked change in the teaching of all subjects in the common school. The method of realism in science subjects is a good criterion of method in all studies. A proper attitude of a teacher in handling science topics in a class is a direct protest against the major part of the work in all studies now done in our schools.

We talk about science teaching, realism, sense training, experimental work, investigation, field work, etc., and still we hug our books as tightly as before. If we were dropped into a school of eighty children without books or paper, as was Pestalozzi at Stanz, we might be helpless. True science teaching is the direct realism of education. In nearly all other studies we can get along with books and deceive ourselves, more or less, with words. But in introducing children to nature studies the absurdity of using books is more apparent than in other branches of learning. In natural science, therefore, more than in any other

study, we are forced to find the true method of object study. We are dealing with those objects and phenomena which stimulate the mind to its fundamental activities and supply it with elementary material of thought. Nature study furnishes the constructive materials and illustrations out of which other studies explain and make real their notions. In its own right, nature study is the direct acquaintance-making and examination of these objects at first hand. It is, therefore, the true parent of all realism in studies (realism used in the sense of object-study). In contrast to this we see an oppressive verbalism still prevailing in the schools, and the heaving of general notions to the front in most text books and recitations. The movement from particular to general, from percept to concept (general notion) is not yet recognized as the primary law of learning. It is strange that nature study with its objective realism is not yet come into possession of its rightful patrimony? Nature study, more perhaps than any other branch of learning, advertises the foolishness of forcing upon a child the general notions, the principles, before the illustrative materials have been presented to his mind.

The world of nature is the chosen domain of a child's operations; it is the field of his enterprise, of his efforts at self-expression. Nature holds out objective inducements and pleasures and invites him to varied effort. Even if the stimulus comes

from literature, as from myth or historical story, the place for actualizing his ideas is in his physical environment. Robinson Crusoe, for example, is the starter for his making a variety of experiments and investigations upon the dogs, parrots, grain fields, clay, and other animate and inanimate objects in his own physical surroundings. This is the way in which all historical and literary works should be studied in the schools, with feet upon the ground though the eyes be turned to the stars.

We may find, therefore, that the effort to discover the best materials and methods of science teaching will bring us face to face with the broader and deeper problems of the school course. Science teaching has a direct word of warning and of helpfulness to all the other studies. It speaks also to the heart of a child as well as to his senses in all his earlier years. Its place, therefore, in the child's life and in the school curriculum is one of no mean or secondary rank.

Nature study includes the whole broad territory of the physical universe. In order to make the notion explicit, we speak analytically of the natural sciences, botany, geology, zoology, physics, chemistry, physical geography, astronomy, meteorology, physiology. But this list is simply explanatory to older people. From the standpoint of pedagogy, nature study is not a collection of sciences, nor a scientific unity of all sciences in

one, but a practical grasp of the whole physical world around us as a set of conditions environing a child. The best way to look at nature is as a body of educative materials, pressing upon the children from all sides, calling out their activities, and impressively iterating the simplest real lessons. There are two phases of artificiality in science teaching which we wish to avoid in the early work with children, though both are indispensable as we advance into higher grades. One is the notion of scientific classification, which to mature minds is identical with any notion of science; and the other, the use of books in science studies. Nature, as she thrusts herself upon the attention of children, is neither classified nor bookish. Nature shows herself as an interesting collection of physical realities, and it is only little by little that children discover and recognize the threads of system running through these objects and activities, and still later that books appear at all helpful in getting at the explanation of things.

GENERAL PURPOSES.

IF WE inquire among thoughtful instructors in science what the purpose of this study is, we shall get a variety of answers, somewhat as follows:

The training of children to observe closely and accurately so as to form habits of scrutiny. This includes the sharpening of the senses to acuteness and vigor. It includes, also, the storage of elementary percepts of strictly experimental type. We deal with those objects and phenomena which stimulate the mind to its fundamental activities and supply it with the elementary materials of thought. Nature study leads also to thoughtfulness and the exercise of reason upon the materials presented. It arouses and feeds the spirit of inquisitiveness and investigation. It not only awakens an interest in the causal relations of nature's work, but teaches respect for the law-abiding quality and truthfulness in nature, as grounded in the realism of experimental knowledge. Nature study is also directly useful for its deepening and extension of practical knowledge, as in the lessons of health, temperance, and sanitation. It reveals the utilities of natural products and

the inventions and processes of man's ingenuity as embodied in telescopes, microscopes, steam engines, medicines, ventilation, photography, mirrors, the compass, pumps, etc. Without a real knowledge of these things, children and grown people cannot adapt themselves to the physical conditions and necessities which their own bodies and the objective world around them impose.

Nature study leads up gradually to a grasp of scientific classifications, of the systematic order and law that prevail in the world; in short, ultimately, to a perception of the plan and wisdom that pervade nature. Here we are upon the threshold of religion. The esthetic interests and tastes cultivated by nature study, the perception of beauty and grandeur and harmony, are among the strongest educative influences of science study. Some even claim that nature is essentially moral in its teaching, and we may all agree, at least, that indirectly many moral qualities are strengthened by a wise method of science study.

HISTORY OF SCIENCE TEACHING.

BY AN inquiry into the history and present status of nature study in the grades we shall find that all these ideas have their influence with teachers, one person laying stress upon one phase of science training, another upon some other. Not only so, but there has been a decided evolution and progress in ideas of method in connection with science instruction in the grades.

One of the advantages belonging to the study of European schools is the opportunity to trace the development of method in particular studies as well as in the school course as a whole. The schools of Germany, for example, have a much longer and more gradual development under trained, even expert, instructors than ours. For more than a hundred years they have been working steadily at the problem of science teaching in the common school, and, having passed through a series of progressive stages, have worked their way forward to a position commanding a liberal and practical view of the whole subject. From the rich experience of others we might learn a valuable lesson but for our lack of confidence in

the plodding Germans, as we sometimes call them, and had we not such abounding confidence in our own ability to solve the most perplexing problems at short notice. But great educational problems are not solved in a day—not even by Americans. Sometimes even centuries seem to pass by without clearly marked progress. At any rate it is tolerably certain that a number of years must elapse before a satisfactory course in nature lessons for the grades can be fully worked out and put in practice.

The following brief historical view of the successive ideas that have influenced science teaching is suggested by Dr. W. Rein's discussion of natural science in the fourth school year (Das vierte Schuljahr).

In taking up nature study in the common schools, the first idea to make itself practically operative with teachers and book-makers was the notion of the *wonderful.* Curious or remarkable plants or animals were talked of or read about. Teachers presented children with something marvelous or prodigious in nature to excite their curiosity. Things even freakish or outlandish were called in to satisfy this thirst for the marvelous. Quite a number of the elementary science books now in use in our schools are mainly devoted to a description of such curiosities in nature as the big trees of California, Mammoth Cave, the ant-eater, an elephant hunt, the duck-

bill of Australia, an iceberg, a geyser. This primitive impulse to feast on foreign wonders and curiosities is directly contrary to two of the most important requirements of good science study, first, that the objects studied be taken from the home neighborhood, as the house-cat, the dandelion, the maple tree, the butterfly, and other objects already familiar to the observation and experience of children; and second, children should learn to see wonders in the commonest objects, instead of going to the world's end to find strange things. Such study of foreign wonders can only be made through books, pictures, and verbal descriptions, while true science teaching throws books aside and shows children how to look nature directly in the face. It is a curious fact that this first impulse to seek extraordinary and freakish things in nature is the exact opposite of the true method of nature study. The whole tendency of this perversion of method is to put our trust in books rather than in our own powers of observation, and to cause children to disregard the marvelous things all about them in nature, and to chase the world over on imaginary journeys in the search for curiosities. The tendency of this perversion of nature study is to teach dependence upon books and hearsay, and even upon what is mythical, instead of personal observation and direct experience. It turns the mind away from surrounding realities toward distant uncertain-

ties. Yet the impulse to find out the wonderful in nature is legitimate and inspiring, and is one of the strongest motives in nature study. Only let it begin at home with familiar objects, and rest upon the undoubted realities and wonders which every child can find for himself at his own doorway.

The second idea which early showed itself in science studies was the doctrine of *utility*, the practical value and information contained in this study for the average man or child. It is certainly worth while to know the useful and hurtful things in nature. The study of plants and trees brings out medicinal or poisonous qualities. Some animals and plants are of daily use to men for food or clothing or shelter. Some of the simpler lessons of physics, chemistry, and physiology have to do with comfort and health, while the common inventions and machines in general use in our homes, fields, and factories need to be explained in science lessons. This notion of the utility of science studies has a wide range of meanings, from the low mercenary motive of personal gain, up through all the steps of practical benefit to the highest utilities which nature has to offer in her service to man. One of the most striking characteristics of the physical world in which we live is the multiplex utility of natural science in the affairs of all classes of people in all their daily concerns. So far as there is progress in the world, men are everywhere seeking to understand and to

utilize nature, and it is one of the great problems of education to prepare children for real life by securing to them such an understanding and mastery of the physical conditions of life and of the many and varied utilities in nature. In the early history of science teaching, however, the utility of nature study was thought of in a narrow and illiberal sense. The poisonous and useful plants and animals marked the limit of the study.

In the third place a more significant and fruitful notion of science came to notice when teachers asked the question, What mental *discipline* is supplied by these studies? Rising above the bare question of utility, teachers inquired what mental habits and tendencies science studies fostered. Most science teachers today lay the chief stress upon the mental discipline afforded by science, that is, the training of the observing powers of children, the quickening of the sense perceptions, learning to see and hear and take more accurate note of the things seen and heard, the habits formed of observing, comparing, and tracing relations, the respect for law and order and truthfulness impressed by such realities. All these are doubly emphasized by science teachers of our day. Perhaps no other idea has been so much exalted by science teachers as this peculiar mental discipline which, it is claimed, is not furnished by other studies. Stated in the above form this aim is comprehensive and stimulating, but when reduced

to the practice of the schools it runs into serious error and difficulty. The test for all such drill exercises, which aim at discipline and habit of observation is the power to *describe* the objects seen and compared and description becomes a mania. In order to carry this observation drill into school a variety of natural objects is examined and described as to form and appearance, color, quality, and materials. Trees, plants, and flowers, birds and insects, crystals and minerals are drawn into this descriptive process which easily degenerates into a smooth rut. Every tree is analyzed into roots, stem, and leaves, every flower into calyx, corolla, stamens, and pistils, every leaf into ribs, veins, and margins, etc., through all the round of nature objects. Such descriptive work may easily grow into a barren detail of external form and feature. The spirit of science teaching drops out and only the empty form of discipline remains.

A special advantage reputed to spring from this descriptive drill is *language training*. But science is too important to be made simply a handmaid of language exercises. In fact if lessons fail as science lessons they will doubly fail as language. Training children, therefore, to observe and describe, is not the leading aim of science study. Its tendency is so strong in the direction of formalism and superficial study of objects that it soon loses all power to stimulate effort. It does not lay hold of the deeper impulses, the wide awake interest

and stronger effort of children to trace out causal relations, to discover the hidden law, to explain, for example, the construction and use of different organs in plants and animals. In spite of the emphasis placed by the scientists themselves upon this disciplinary value of studies, in spite of the strong necessity for right habits of observation, the mere discipline derived can not be regarded as the controlling aim of these studies. The real purpose of science teaching in its higher influence is not bare mental discipline but the permanent awakening of the whole mind and spirit of the child. Discipline, therefore, is one of the secondary or incidental aims of science instruction.

In the progress of science teaching in the schools a fourth and more comprehensive aim has been set up and put into practice. It is the idea of *scientific order* and *classification*, the reduction of all the varied objects and phenomena of nature to an accurate system of classes and sub-classes, of general and special laws. It is an effort to get the mastery of nature by reducing its endless variety of forms and phenomena to system and law. Dr. Rein says: "In the latter half of the last century lived the great founder or reformer of systematic natural science, Karl von Linnæus. His influence reached far into the nineteenth century and was universal. Goethe himself affirms that next to Shakespeare and Spinoza, Linnæus exercised the greatest influence upon him.

Through Linnæus, system came to the highest renown. In the effort to set up a system, which would satisfy all requirements, was recognized the highest aim of scientific natural science. In quick succession followed the systems of many scientists. Is it any wonder that system, even down to the common schools, became the chief aim of natural science instruction? Moreover, the pursuit of this aim seems to satisfy an inevitable need, that of bringing knowledge into order, by means of order to get a survey of the multiplicity (die vielheit) of single things. For without a principle of order this multiplicity would become an unbearable load." (Das vierte Schuljahr, p. 115.)

The drift toward scientific classification or system has been very strong with us, especially in high schools and colleges where most teachers are trained. In the study of botany, for example, the chief effort was directed to analysis and determination of specimens. When this process had gone on long enough to secure a superficial grasp of all the important classes of plants the chief result was attained. The zoölogies, a few years ago, contained a full classification and brief description of the leading families and orders of the animal kingdom. The text-books in physics and chemistry also gave a brief outline of those sciences. In all these cases the text book played the principal role, and the true scientific method of experiment remained unreal-

ized. The text-book methods followed systematic aims, but as we have broken with the text-books and come in direct contact with the objects in nature, other aims than those of classification have become prominent. In elementary schools, especially, it is not well to emphasize classifications but to rest the work more upon particular phases of object study and experiment. The studies for children should be individual and biographical. A life history of butterfly or squirrel, or fish, with a sufficient consecutive observation into details and gathering of facts so as to give a deeper insight into habits and mode of life, is necessary. Until we can furnish teachers and children with the opportunity of making such biographical studies in nature, the science work in our common schools must be greatly hampered. The strong tendency of text-books in natural science to be systematic (that is, to give the outlines of a system), almost completely destroys their value for the common schools. And yet all true nature study leads up to the system and order of the universe. As children gather up the rich materials from the biographies of trees and insects, of fish or bird, they will gradually gain comprehensive views of the chief classes and underlying principles of order. The whole movement in science teaching is toward an adequate grasp of classes and laws. The great mistake is made in trying to begin where we ought to end. Classifi-

cations are the abstract forms of science and sum up the results of study, while the characteristic value of early science lessons is their concreteness. Children are easily and naturally attentive to the concrete phases of object study, while they turn away in dislike from the barren study of classes. If we can answer the question how to approach the general truths of science, we shall probably have the solution to the most troublesome problem in this study, and at the same time settle some of the most vexed questions in methods of teaching.

THE LEADING AIM.

WE ARE not content, therefore, with any of the four aims of science study thus far suggested. Neither singly nor combined have they sufficient value to stand as the central, controlling aim of the great procession of nature lessons. How, then, shall we find a standpoint from which to survey this broad field of studies and discover the leading aim for its conquest?

We may get a suggestion of the proper attitude for attacking this problem from the child himself. He is the one, after all, who is most concerned with the outcome of our theories. What use has he for this large world of varied realities both now and in the future? If you ask him the question outright, he will remain as speechless as the sphinx, but if brought face to face with nature's teachings he may respond heartly in a score of ways. As parents and teachers it is our business to take a sort of composite photograph of a child's present impulses and future needs, and then, by combining our knowledge of children with the garnered wisdom of the world in matters of education, we may possibly discover a method of teaching which will satisfy a child's present grow-

ing needs for food and nourishment, and at the same time fit him for his future life in the midst of nature and society. If the old saying is true that the child is father to the man, that is, foreshadowing what the man will be, he has within him those better instincts and tendencies which, if properly developed, will make him the father of the right sort of man, that is, the instincts which will prompt him to respond vigorously to those methods of science study which gave him the best preparation for life.

We may state the broad aim of science studies as a responsive *insight into nature*, an interested understanding of the materials and activities of her great workshop, an appreciation of the variety, beauty, harmony, and law of nature's handiwork. If a child is to reach maturity with a proper insight into physical laws, forces, products, utilities, and inventive appliances, he must begin early to train his eye and his understanding to look into these wonders. Yet this is not a dull business to a child. It is the very thing he is most of all inclined to do if kept in a proper attitude and prudently guided in his employments. It falls in with his present impulses toward physical activity and mental expansion. The native interests which call forth his energetic effort, both physical and mental, are powerfully directed toward the many curious and useful attractions in nature. Nature study should lead to something beyond useful

knowledge, sense-training, observation, discipline and the mastery of scientific order and system. With these and through them it should appeal to his instinctive interests, because of its recognized value to him, because it reveals the physical world to him and to his needs. It thus enters as a constituent element into his own personal culture and growth; it becomes a part of his life and character. If we devote our whole energy to any of the secondary or subordinate aims of science study, we shall make the work mechanical and superficial and not attain even such lower aims. If we follow the higher aim, to give to each child a personal insight, a sympathetic appreciation of the realm of nature, so far as it can be grasped by his mind, if we seek to enshrine all this knowledge in his tastes, interests, and feelings, we shall find this phase of culture an essential agency in personal character development. Not that it contributes directly to his moral sense, but it appeals to his esthetic tastes, religious instincts, and human wants. It supplies him with the materials and tools for the exercise of his present urgent activities, and its utilities are found to be so interwoven with the comforts and progress of men that nature is seen to lay down the conditions of life. Every child, therefore, should go into nature studies up to the full measure of his powers and come out enriched in knowledge, in discipline,

and especially in sympathetic insight and strong personal attachment to their teachings.

The broad aim of science teaching, as quoted from Kraepelin by Rein, is as follows:

"The aim is to open up to a pupil an understanding of the present and to find thereby a frank and all-sided philosophical view of the world, founded upon reality and truth. Nature should not present to man the appearance of an inextricable chaos but that of a well-ordered mechanism, its parts fitting exactly to one another, ruled by unchangeable laws and engaged in perpetual labor and production. The proof of order in the world-whole is made clear to the investigator by setting up a system of things; the exact fitting and mutual interaction of the single parts reveals itself in the thousandfold relations of natural objects to one another; faith in laws governing the whole is produced by a knowledge of an ever-consistent causality, while ceaseless activity and production arise out of the coming and going of individuals as of generations."

This is a comprehensive and well-phrased statement of the aim of science teaching from the knowledge side. The method of approach by which the attitude of the children toward this great body of educative material is determined is of equal importance in considering the educative aim. The fundamental question in this study, as in others, is the influence of these materials and

of the method of their acquisition upon the character of children. The selection and arrangement of topics in natural science, together with the method of working them over into knowledge with classes, is just as important as the organized knowledge itself.

The aim set up for natural science studies calls for the surmounting of two commanding difficulties. On the one side the ultimate purpose to reach something of a scientific mastery of the order and system of nature, and on the other side to reach efficiently, through the matter and method of the study, the character of the child. The conquest is the child's in both cases under the teacher's guidance.

A ROAD TO THE AIM.

TO STATE such an aim as this for nature study in the common school is easy, but to illustrate and work it out in detail so as show its practicality, is extremely difficult. It is incumbent upon us to point out the line of effort which will lead to the aim given.

The first prominent requirement is to select a series of topics for the grades. The endless variety and multitude of objects in nature, the great diversity of branches as botany, geology, physics, and astronomy, seems at the start to make a selection very difficult. In any limited department of science like zoology, it is not easy to establish the true order of development of the subject, whether, for example, to begin with the lower, simpler forms of animal life or with more complex and highly organized groups. But in nature-study considered as a whole the question comes how to select and arrange materials drawn from a dozen widely different sciences.

The question might be asked in the first place whether we need a graded course of science lessons somewhat definitely laid out. We answer in the affirmative. The great difficulty with most

teachers, who would be glad to teach nature lessons, is that they are not sufficiently well versed in scientific studies to select and arrange a series of lessons for any given grade. But if some one capable of making such a list will outline the suitable topics, the teachers of that grade can set themselves to work to qualify along the lines of those topics. If the one selecting will also take the pains to suggest the best ways of collecting materials and of observing, and point out a few of the most helpful books, teachers will be able to make rapid progress in teaching. There is simply no question but that the great majority of teachers need definite suggestion and help in selecting and arranging their topics, and in studying up and observing by way of preparation.

Taking it for granted, therefore, that work of this kind is imperatively needed, it will pay us to still further draw the necessary limitations that surround this work so that we may more definitely comprehend the nature of our task. The subject before us is not natural science (classified knowledge), but nature study. We are seeking to know nature in her real forms, as she shows herself in field, forest, and shop, not the classified orders and system of the scientific books. It is the concrete, living forms that we deal with rather than the principles and schemata of the scientists. Again, we shall not master any of the sciences even in their outlines. We are not aiming at

scientific completeness. A fixed quantity of knowledge and the fullness of detail necessary to a system are not necessary to our purpose. We shall select a few of the best type forms and enter into their concrete details and relations.

The selection of topics will not be based upon a strict scientific order, either in one or in all the sciences. This scientific order will not be ignored, but it will not control. Pedagogical considerations will determine in the main the order of topics.

For the first four grades, which we shall consider in this book, we will confine ourselves mainly to biology, or the study of plant and animal biographies. The common objects of the home neighborhood will be mainly studied. The season of the year will often suggest suitable studies. The best scientific types of great classes or processes in nature will be selected for detailed investigation. The history, literature, and geography of any given grade will suggest a variety of science topics. Many of these, so far as they harmonize with our other principles of selection, will be chosen for treatment, because they help to bind the science topics with those other studies.

The study of plant and animal life seems peculiarly appropriate to children. They like especially the activities of animals, the observation of their movements among the trees, in the air, or in water. Of all things in nature, animal life

comes closer to the children because they find so many likenesses to their own activities. Plants and flowers also attract them, and they love the changes and processes of growth, the seeds, flowers, roots, fruits, and uses of natural products. There is a sort of personal interest in the study of animal or plant that is lacking in other forms of nature study. The seedling plant grows, feeds, and develops as does the child. It has its dangers and enemies, its childhood, maturity, and old age; its winter and summer. For a child to trace the butterfly from the egg through its processes of change and final perfection in the insect state, is a very interesting biography.

Second, the commonest objects of the home neighborhood will be minutely studied. This is the true basis of proper study; it gives the fullest possible opportunity for real observation and investigation. Even the common weeds, like the burdock and thistle, are far better than exotics. The study of home objects should come first, because it forms a good basis for later study of more distant ones. Besides, the home furnishes, among plants and animals, enough types for a comprehensive study of these subjects so far as needed.

The season of the year must determine to a large extent the best time for the study of plant and animal life. The budding and blossoming of the trees must be noted in the early spring. The bees can be studied in spring or fall; the spring

plants may be dug up in spring-time; the seeds and pods are best noticed in autumn; the evergreens may be taken in winter and spring. Of course, any given tree or plant needs to be traced through the season, and the robin should be seen on his return, in the nesting season, and when he returns to the South in autumn.

The type studies form convenient centers of instruction, which prove serviceable both scientifically considered and as a basis for pedagogical treatment of topics. It is better to make a full and careful study of one of the rodents, as the fox-squirrel, with the descriptive detail of his nest, habits in summer and winter, his food and rearing of the young, his enemies and devices for escaping them, his noises and movements in climbing and running, his fur and its uses, the make of his teeth and claws as suited to their uses, and his kinship with other squirrels. Such a biography of individual and family life among squirrels gives not only a graphic picture of this little animal, but allows a variety of observation and comparison with other animals, similar or opposite, that may be incidental yet valuable. In the same way the study of the cow among ruminants becomes a type of that class, the milkweed butterfly among butterflies, the maple or oak among trees, the dandelion or thistle or sunflower among composite flowers. The type form, when fully described in its continuous life history, is not only a very

interesting and instructive object to children, because of the abundance of attractive detail, but it is a key to the understanding of a multitude of similar or related plants or animals. The study of the cat, for example, as to retractile claws, eyes, and muscular and bony structure, gives a clear view of a whole class of animals. A brief comparison of the domestic cat with the tiger, wildcat, etc., is all that is needed to make the knowledge fairly complete. Without the guidance of these larger units or type forms, the topics chosen by teachers are often very partial or miscellaneous. For example, the study and comparison of leaves on trees, the comparison of twigs, and the arrangement of buds and twigs, or leaves, on the stem. Such topics come up incidentally and naturally in the handling of a type.

The type studies furnish great units of thought, which are complete, very suggestive in a purely scientific sense, and yet full of the interest and information of a continuous biography. They give also an insight into great processes in nature, as the development of an animal from the egg and its growth and changes till maturity and death. The type form, thus fully studied, allows of the tracing of those deeper causal relations of a plant or animal to its environment, to other plants and animals as well as to soil and sunshine, to weather and other influences, which bind any topic with many other topics and knit

the sciences into a net-work of mutual relations.

The series of topics for science work in the grades will be determined largely also by the suggestions of the other studies. History and geography and literature have many references to topics in natural science. In laying out a course of science studies it is no longer possible to disregard the close relations of the other studies to natural science. This is especially true in primary and intermediate grades where the number of science topics relative to plant and animal life suggested by literature, geography, and history, is very great. The fairy stories and fables used in first and second grade, the Robinson Crusoe in second and third, and the myths in third and fourth are full of plant and animal life. The pioneer history stories and the geography of our own country in fourth and fifth grades are rich in natural products and references to vegetable and animal life. The closer these subjects are drawn together, the more intimately they stand related and support one another, the more telling will be the effect of each branch upon the children. It is no longer possible to make out an isolated course of study in natural science. The combined effect of all studies upon a child is the great consideration and the knowledge and discipline each furnishes may be got into the bargain.

The selection of a few important type studies, each of which is to be worked out in full detail, has the following advantages:

1. Each type is an important center of thought around which to associate a large body of related material.

2. Each type is the representative of a large class of more or less similar objects (basis of classification).

3. Great abundance of concrete material is gathered about each type object, contributing to interest and clear perception.

4. A continuous biographical study of life-history or development has strong interest and consecutive force.

5. The deeper causal and vital relations that bind plant or animal to its environment can only be traced out by this detailed study of a single important object.

6. A single important topic is kept before the children long enough not only to gather up a varied collection of experimental knowledge about it, but to organize it, and to bring it into relation to other topics.

7. The type studies pave the way to a recognition of *general laws* in natural phenomena which give the most comprehensive views. This process of working up to an understanding of the general laws of nature is so important that we will consider it separately.

The second principal means by which we seek to realize the chief aim of science teaching is by studying out the general laws which underlie the phenomena of the organic and inorganic world.

Children are to acquire gradually an insight into the unity that prevails in nature. At first the endless variety of objects and activities in nature gives a child no notion of the underlying harmony and connection of the varied parts. but as the insight into wide reaching laws is revealed to him he finds strong links of union, binding all the parts into one.

This unity shows itself in the life of any plant or animal, in the laws which govern its internal organization and external adaptation of organs to environment.

Junge, as quoted by Rein, presents this unity in nature based upon laws as follows:

"Life is characterized first of all by the fact of *movement* either of the inner parts of a body (its constituents) or of the external parts or organs. These movements have a connection dependent upon the whole as a totality of parts (law of construction or of connection). If no agreement were found in the mutual relation of all the parts they could not be united into a whole. The cause of these harmonized movements is the indwelling agreement of the parts, not an external force (contrast of organism and mechanism).

'Through this movement is brought about (1) the growth and development of an individual from a lower to a higher stage of completeness; (2) the preservation of the thing itself. The indwelling effort of all the parts or members toward the preservation and perfection of the whole is the life principle (law of preservation, accommodation—of organic harmony, of development). Let the impulse to harmony of inner or external movements cease, there enters a condition of decay and death.

''Life in nature is a unit not simply as far as each organism constitutes a unity, but also so far as an agreement shows itself in the inner causes of life activities in different individuals, that is so far as laws manifest themselves. The laws prevailing in individuals have at least a strong resemblance to those which rule in a whole group of individuals, a life society (even the earth considered as such), though the laws are not just the same.

''Children should get an understanding of life in its unity. Now it will not suffice to secure to children an observation of life manifestations. Such knowledge could be called at best only information about life. An understanding of life depends upon an explanation of phenomena as based upon causes permeating the whole, as based upon the laws of life activity. Without a knowledge of and application of laws, there is

no understanding, just as in instruction in physics, when we bring out no law, but offer the children a motley variety (as *e. g.*, an ordinary scale, a see-saw, a steel-yard, a crowbar, a wheelbarrow, a pair of pincers, etc.), so all nature without a knowledge of laws, remains a kaleidoscope, which, according to the play of chance, ever brings out a different picture with the same colors. When we bring to notice a law—though not mathematically exact in its formulation—it furnishes the mental unity or means in all these varied illustrative forms (of the lever). So throughout the whole of nature by means of laws there is revealed in the midst of the most striking diversity a uniformity of life which reaches even into human affairs.

"Should we inquire upon what road a knowledge of the facts and changes in nature, both in single things and in more complex wholes, may be reached, a brief consideration will give us a ready answer. The simpler, *i. e.*, the less intensive and extensive life displays itself, the more easily can the laws of its manifestations be recognized. They are more easily perceived in the changes of inorganic than in those of organic nature. The life of a lower organism is more easily understood than that of a higher; the life of a single organism easier than that of a life society; and, finally the life of a group or life society, accessible to observation, more easily than one of the whole earth. The following serial order, therefore, re-

sults: 1. Observation of life in the single thing and successive recognition of the different fundamental laws; 2. Recognition of the discovered laws in small life groups accessible to the child's view; 3. Application of the laws to unfamiliar objects and life societies. 4. Application and rediscovery in the entire life of the earth. It is not necessary to satisfy the above mentioned requirements in a strict schematic way. Schematism would do violence to organic development and comprehension. It is rather advisable at every stage of progress to aim at a well-rounded whole, and in view of the final aim to make use, little by little of the results springing from the other natural sciences as the progress of instruction renders them possible. In a final course all the knowledge gained at different times from different natural science fields should be elaborated into a unity in consciousness. Thus children acquire a conviction and an understanding of life upon the earth, in whose chain of created things man also is a link. He learns also to see himself in the mirror of nature."

In biology, which furnishes a large share of the topics for science lessons, there are two kinds of units of thought, single animals or plants and life groups. The single animal or plant, as a type, we have already discussed. The biographical story, or life history, in full, of such a plant or animal, especially when brought into comparison

with similar biographies of other plants or animals, reveals many of the fundamental laws of organic life in nature.

The *life society* or group is a much more complex object of study. It is not a scientific group, but a natural group of closely related and mutually dependent objects in nature. A natural forest well illustrates such a group, the various forest trees, the wild flowers and grasses peculiar to woodsy places the birds and squirrels and insects that naturally find their homes and food among the trees. Even the soil, moisture, and sunlight, among inorganic things, contribute the conditions for a mutually dependent and helpful group of living organisms. The birds depend upon the trees, the trees depend on insects for the cross-fertilization of flowers; the bloodroot and other wild flowers flourish in the shade of trees. The study of the different members of this family group, and the study of the whole varied family in its relations will bring out still other fundamental laws in nature.

Rein says: "As the basis of our studies, we are called upon always to select a natural whole; and first of all, such a whole is found in every single living object, for each is an organism, *i. e.*, a thing whose parts stand in relation to one another and to the whole." Nature study, therefore, should deal not with fragments, but with wholes; not with leaves or buds as isolated topics, but with

trees or plants as wholes of which the leaves or buds are parts. The unit of thought should always be in mind and stand as the basis of study. "A single living organism, however, is only a part of the great world machine. In many of its relations it is dependent upon other objects, as a strip of earth, etc., which influence it and in turn are influenced by it. Thus we find different objects together. A number of objects bound together by common or similar needs or by mutual aid rendered, form a *life society*, in which each one fills out its place and part in the whole. These life societies are considered as composed of organically connected single things. When several such life societies, as for example, forest, field, swamp, meadow, etc., whose unity the children can survey, are observed and their importance for the home brought out clearly, for which all taken together constitute a unity; by such observations the way is prepared for an understanding of the entire life of the earth. Such wholes, whether single objects or life groups, we analyze into their parts and inquire, what parts are these, what purpose have they, and why so made and not differently? With a plant before us we notice the parts. As to the root, we observe not only its fibres, but its work, and why so constructed; why different in sand, or clay, or in rich soil. The leaf is noted as to form, also its function and the reason for its being flattened

out; why in water plants it is modified by the depth of the water; why in land plants it is sometimes hairy, sometimes hairless. So, also, in the study of animals. Organ and function should always be brought into the closest relation. So we come to understand why a foot is modified to adapt it to a changed purpose, as a webbed foot, a wing, or a hand for grasping; why the skeleton of birds, for example, is different from that of mammals."

By the constant emphasis of the correlation between organ and function, the child's mind is kept awake to the fact that he has to do with a living thing, for the eye must pass from the construction of the organ to its use in life, and *vice versa*. In the second place, we satisfy the demand for causality, which is really the impulsive element in the development of the human mind. That this is present in the child is manifest in his many "whys."

The study of these laws and causal relations between objects and life groups in nature reveals in a striking way the total inadequacy of a method of science study, which isolates the different sciences, as botany or zoölogy, and tries to build up a system and classification of each by itself. In the biography of any animal or plant, and also in the life societies, the vital organic relations between plants, animals, minerals, sunlight, etc., are cross sections in the sciences,

which disregard our efforts at isolation and artificial system making. It is in these inter-relations of the different sciences that we find the deeper and more instructive causes operating in nature. Classifications in botany or zoölogy are important, but the study of causes acting between different sciences is often more significant, instructive, and stimulating.

"We answer the question —Why?—by referring to a cause. A definite form of statement for the connection of certain effects with certain causes we denominate a natural law. (In this connection we should not forget that laws are not the causes of phenomena.) We do not expect, of course, to give these laws to the pupil, and we shall not be over hasty in pressing for their formulation. When the pupil has found out in a large number of living things that while structure and life show great diversity, yet certain mutual relations always come to light, that a change in the one always means a change in the others; then it is not premature to let children derive the most important biological laws. 'They are the constant, permanent element in the ebb and flow of phenomena, as it were the spiritual in nature, and nothing short of the tracing back of phenomena to these laws can give an understanding of life, and—so far as the laws are universal—a knowledge of the unity in nature.' (Junge.) So long as no law has been worked out, the teacher must be

the guide in making observations. The laws, or rather the final aim of the natural science instruction, must be ever present to his thought, whether he be selecting the material of instruction or employed in its treatment. When a law has been once recognized, then in many cases it may assume the leadership; it gives direction to present undertakings as well as to future observations and experiments. Pupils now examine living creatures according to the measure of one or more laws; they begin to investigate the question whether, in a given creature, manner of life, habitat and structure of organs correspond, or whether an organism develops from a simpler form up to a stage of completeness, etc." (Rein.)

The last sentence suggests the two simple fundamental laws by which most of the phenomena of organic life (plant and animal) may be interpreted and a deep insight gained into life processes.

1. Is the law of *physiological purpose*, or law of preservation; that is, manner of life, habitat, and structure of organs correspond. Every animal or plant is peculiarly adapted by its organs and mode of life to its environmont. To discover and trace out this law in the varied and widely divergent forms of life, is one of the most instructive and permanently stimulating thoughts in nature study.

2. Is the law of *development.* Every organism develops from the simple up to the stage of com-

pleteness. Here again, to trace the life history through its successive stages of growth up to maturity, reproduction, and decay, reveals amidst endless variations a sameness and constancy of life processes which make nature's work almost wonderful in its simplicity. Still other important laws which may develop out of thoughtful nature studies are taken from Junge, as follows:

3. The law of *adaptation* or accommodation, manner of life, and structure of organs adapt themselves, within certain limits, to a changed habitat or set of relations. Beyond these limits follows the death or crippling of the organism.

4. The law of *division of labor* or differentiation of organs. The more the whole work is distributed to different organs the more perfect is its execution. Or, the more numerous the organs for different services the more perfectly can each organ perform its special service.

5. The law of *organic harmony* is the first law applied to the earth as a life society.

We have dwelt somewhat at length upon these laws because they serve so well to illustrate the possibility of making such a study of nature in the organic as well as in the inorganic world as will lead on to a simple and practical conception of the unity in nature. Moreover it is the actual unity which, as based upon persistent and omnipresent relations of cause and effect, reveals nature in her ordinary dress and not in the arti-

ficial form of scientific classifications, isolating the different sciences from one another.

In the study of life histories, life societies, and in the working out of simple fundamental laws, we may lead on to a grasp of the unity of life processes in nature and to such an interest, insight, and habit of study as to greatly influence character.

The influence that nature study has upon character depends largely upon the hold it gets upon the child's affections. It is not simply a matter of discipline, but also of attachment and interest. The sources of stirring interest for children in nature study are so abundant as to give a strong and steady impulse to work and will effort. Herbart has pointed out clearly that three of the great fountains of interest and inspiration spring from the roots of nature study as the sources of great rivers gush from the foot of mountains.

1. The empirical interest so universal among children deals with the superficial phases of nature's manifestations, the change, variety, and generally pleasing and attractive face of nature. There is, even among little children, a native powerful impulse to get into the fresh air, the sunshine, and out-door contact with nature.

2. The speculative interest works down into causal relations, gets beneath the surface of phenomena, and reaches out over broad areas in search of more or less general laws. The causal

idea is an all-powerful impulse alike for children and mature scientists in science study.

3. The esthetic phases of nature's handiwork, the beauty of form, color, and proportion in the flower, bird, insect, cloud, mountain, etc., furnish limitless and constant opportunities for esthetic appreciation and culture. Many think this the choicest part of nature study

METHOD.

THE METHOD of teaching natural science is difficult to describe or explain. The teacher's duty in this case is somewhat different from what it is in other studies. The book of nature lies open before the children and the teacher is to lead them to read and appreciate it. For most persons this is more difficult than to learn to read books. To gain insight into nature children must learn to look beneath the surface and detect the working forces or the hidden law. Nature's secrets lie hidden under the surface of phenomena and children must learn to uncover the facts and look at the inner workings.

As in other studies, one of the first things preliminary is the selection of important *type* topics which are to be fully treated. On the supposition that a series of such careful selections has been made, we approach the question of method in treatment.

We will suppose the subject chosen is the *red squirrel* or fox squirrel. Let us first see clearly the aim. We are to make a study of the squirrel in its whole life history, its biography; not simply a description of a few points of external appearance, but the home of the squirrel in the woods,

its family life, its food and how obtained, its organs as adapted to its peculiar surroundings, its intelligence and instincts, its care of the young, how winter is spent, where the food is stored, its nest, the enemies that threaten it and its means of escape, its structure and organs, feet, teeth, fur, eyes, stomach, and other internal organs. Also its uses to man. The comparison of the red squirrel with other squirrels and with the rabbit, beaver, mouse, and other rodents, will follow this full description. This comparison will bring out the type character and throw light upon a whole group of animals. Such a full study of the red squirrel may require two or three weeks or even longer, but in every lesson we are turning up new soil, getting real instruction, enlarging our knowledge of animal life. So long as new and instructive facts are being unearthed, the subject will not prove irksome to children. The concrete details, the minutiæ of life and habit and structure are just the kind of thought material that appeals to children, because it is fresh, real, concrete, biographical. All the facts brought to light interpret the life of the squirrel. It becomes a person with needs and difficulties, struggling for food and home and safety, and endowed with organs for these special purposes.

The study of a squirrel in its life history is really an examination into a biography, it is a study of animal life as related to trees, grasses, climate,

other animals, birds and insects. It fits into its place in nature as well as a leaf fits in its place on the tree. Now, would it prove equally or more valuable to spend the same amount of time not upon the squirrel alone, but upon half a dozen of the rodents, as the rat, beaver, mouse, musk-rat, rabbit, ground squirrel, etc.? The study of a single kind allows an inquiry into details and causes that a study of many would exclude. Not only are the details attractive and concrete, but they show how to look into a subject, how to investigate, how to trace out habit and structure and their effects. A single topic treated in this particularized fashion gives us the key to the method of observation. By studying one properly, we learn how to observe and trace relations in others. Such a method of exhaustive treatment destroys at the start the natural tendency toward superficial description of external appearances. We grasp at first the significant problem of this animal's life. If we are studying a water bird, we desire to discover how it is adapted to get its food in lakes and streams and to make long flights. We follow it in its migrations and realize its conditions. If a squirrel is studied, we may first ask, where does a squirrel choose his home and build his nest? If a catfish is the subject of investigation, we desire to interpret his life in the water and his means of living and flourishing there.

Every new plant or animal presents a new

problem, not simply a repetition of old questions. Much of the skill and success of teaching depends upon the ability to approach the topics from the standpoint of *significant aims.* The setting up of problems and aims that will cause the children to think and investigate, to collect and interpret facts, is one of the chief demands upon the teacher.

We have now reached the point where we must outline a method of treating important topics. From the previous discussion it is clear that one of the underlying purposes of science instruction is to lead up, through particular concrete studies, to the understanding of general principles and laws, and to the ability to recognize them in their usual operations. Stated briefly, children should learn to understand and to apply general truths. How shall children be taught through their own self-activity and thought power to approach, master, and recognize about them the general laws of nature?

1 They must have a topic under consideration which involves or typifies a general truth.

2. An aim needs to be set up which points clearly towards this general truth, and while it involves difficulties still presents an interesting problem for solution. The setting up of such significant aims pointing toward important discoveries and truths is a strong demand for skill and insight in teaching. It points out clearly

the road to be traveled in the search for truth, and calls out the self-activity and thought power of students. In an oral or experimental plan of study, the setting up of such guiding aims, both stimulates the children and points toward the most important truths to be mastered. In an oral method, such as science teaching demands, it is possible to throw children upon their own resources in the effort to reach the aims set up. A text-book, on the other hand, with its didactic method, works out the problems, giving the solution for the children to learn. In science work children observe, collect facts, trace causes and relations, compare and draw inferences, for the sake of conclusions which are to be worked out by their own thinking and tested by facts of their own seeing. The aim set up should be particular, definite, and interesting, rather than indefinite, general, or abstract. The truth aimed at is first worked out in some concrete setting and afterwards seen in its more general application.

3. While any important topic is up for discussion, the first thing to do is to study it so as to determine the facts. Observe it as a whole and in its parts and the relation of the parts to each other and to the whole (analysis and synthesis). This process of observation or study presents all the facts clearly to the mind in their concrete setting. For example, in the study of the wild duck as a type of bird-life, we would gather the facts

relating to structure, organs, mode of life, food, habits, migrations, nesting, length of life, etc. This is the opportunity for children to be self-active, to observe, to gather facts, to investigate. It is the teacher's chance to guide wisely, to question, to stimulate and not to be over-hasty in forcing conclusions. This is the place, also, for the teacher to give facts which are beyond the experience or reach of the children, and to suggest reference books for their study. If diagrams or pictures, or other illustrative devices are needed to bring out the scientific facts, this is their fitting place. The children need also to verify their observations, to render them into some definite form of expression, in word-description or drawings. At the close of each important topic, a careful and adequate reproduction of the knowledge gained should be obtained from the children.

4. The typical or general character always involved in such a particular study is never seen or realized from the study of a single specimen. We have to look abroad and compare the structure, habits, and life of other wild ducks, and of still other wild birds, and, perhaps, of other animals, before we can draw general conclusions which apply to large classes. In order to reach general truths in natural science it is necessary to make comparisons of many similar and contrasted objects.

5. A general truth or law may properly spring from an observation and comparison of a number of different specimens of the same general class. If, for example, the stomachs of a large number of blackbirds are examined by the scientist at different seasons, and while showing variety of food still point to certain foods as common to all, a general conclusion can be drawn in regard to the food eaten by these birds. It is important that these general conclusions or laws, which are the results of observation and study, should be definitely stated in accurate form and fixed in mind. This gives us our law, principle, or rule in logical or scientific form so far as the progress of the study admits completeness.

6. A general law or truth is not sufficiently understood and mastered by working it out inductively and by bringing it to definite and accurate statement for memorizing. For example, we may illustrate and work out a rule in grammar for the agreement of subject and predicate, but to convert such a rule into habit so that the correct form is easily used when needed, calls for frequent and varied application of the rule. We may understand a rule in arithmetic but many varied and more or less complex applications are necessary to make it a ready guide in arithmetical work. In natural science, also, the applications of truth and law are infinite in variation and complexity. Every animal is adapted to its environment, with struc-

ture and organs suited to its needs, but we must notice how totally different these adaptations are in fish, fowl, and quadruped before we understand the scope of this law, and are ready to detect easily its variety of applications.

Nature study calls forth two kinds of observation which, though opposite, should be cultivated side by side. First, the close analytic study of one important topic and absorption in this object to the exclusion of the many. It may lead on to a succession of observations following up the early history, development, and relations of a single organism. Other topics are shut out so as to concentrate the more effectually upon this one. Secondly, nature study should teach us to observe many things, to have our eyes wide open, and our attention receptive to a variety of objects, perhaps to all the important things that move before our vision. We need, therefore, not only to concentrate but to spread our observations. Children go out upon science excursions. The purpose of the excursion should be centered upon some particular kind of tree, as a hickory, or other object. Careful, analytic study of its parts and their functions is necessary, and the close relation to other plants, insects, and animals should be noted. But, in concentrating attention upon this one object, should they close their eyes to other equally valuable things in their environment? It seems really advisable to kill

two birds with one stone. Make the excursion count for both kinds of development in observation.

It is necessary in any well-planned excursion, which partakes of the character of real instruction, to have some central and controlling object for study, something which supplies the aim of the excursion and determines its plan and movement. But, as we go on our way toward this object, or in search of it, let our eyes be open and watchful for the multitude of interesting objects and phenomena that may meet us by the way. In this manner, incidentally, we shall gather up a large variety of the most valuable experience and not be turned aside seriously in our hunt for the principal game.

If, however, we should go out upon an excursion with no particular aim in view, no particlar result would follow, It might serve well enough for recreation, but not for the more serious work of instruction.

Among the devices for giving clearness and point to science instruction are pictures, diagrams, illustrative blackboard sketches, the use of instruments, experiments, and what may be summed up as the originality, versatility, and industry of the teacher in inventing graphic methods of homely illustration. It is a disadvantage to both teachers and pupils to have too much apparatus and manufactured illustrative material, though some things are indispensable. In spite

of the fundamental realism and direct contact with objects in science study, there are still a good many devices necessary to objectify and make tangible the teachings of science. Many things can not be seen, but must be reasoned out. The shape and movements of the earth, for example, must be typically illustrated. The atomic theory has to be thought rather than seen; the circulation of the blood (in spite of the frog's foot and microscope) must be explained by diagram or manikin. At almost every step our thought goes farther than our sight, and yet needs constantly to be checked up and verified by the actual.

At this point an interesting question comes up as to the value of the *imagination* in science studies. The tendency to exercise the imagination in science is strong in all grades, from the primary school up through the university. Primary teachers, especially, are full of imaginative suggestion to the children, and the children themselves take to the imaginative forms of thought as a duck to water. The baby seed in its cradle is waiting for the warm sunlight to call it up above the ground. The papa and mamma bird take care of their little children. The pussy-willow has its warm fur coat in the chill of early springtime. The snow is a blanket that covers up the flowers in winter. A child thought the half moon was only half buttoned into the sky. Such fanciful suggestions are innumerable in the instruction of

children. Some of the strict-construction scientists are very much opposed to this imaginative tendency in science work. The notion is that science is, first of all, valuable for its adherence to the *real*, for its exclusion of the fancy. Superstition, guessing, hearsay, careless inference, fairy tale, are all shut out, and we are kept close to the unadorned, incontestable facts—the things admitting of no equivocation. Natural science is, of all studies, the one to free us from superstition and convince us of the all-prevalence of law.

It is a curious fact that children, primary teachers, and poets refuse to be bound down to the plain realities. In order to understand nature they fall back upon the aid of the imagination. In the fall they think of the tree as wrapping up its tender buds in scales; a caterpiller was described by a three-year-old girl as a worm with a fur coat on. Teachers who have to deal with children very easily fall into such forms of description as are easily understood by the children. But our poets also, who know how to give distinctness and point to truth, are full of such imaginative touches.

"Every clod feels a stir of might,
An instinct within it that reaches and towers,
And groping blindly above it for light,
Climbs to a soul in the grass and the flowers."

"Laughed the brook for my delight,
Through the day and through the night,
Whispering at the garden wall,
Talked with me from fall to fall."

"The little brook heard it and built a roof,
'Neath which he housed him winter proof,
All night by the white stars' frosty gleams,
He groined his arches and matched his beams."

It would be impossible to quote ten lines of the best poetry of nature without just such beautiful imaginative touches.

One of the professors of natural science in a large university, in lecturing before a body of 1,000 teachers, asserted "that parents, teachers, writers, and educators had combined of late into a syndicate for teaching children lies." This refers directly to the use of the imagination in nature studies so prevalent, especially among primary teachers. The question is whether the imagination can be dispensed with in nature study, either by the child or by the trained scientist. The same lecturer spent an hour with his students describing the different theories of heredity. The question may be pertinently asked, What is such a theory? And the necessary reply is that a theory is not a fact nor a collection of facts of observation, but an effort of the scientist, through his reason and imagination, to give meaning and unity to the facts. Theories are often found to be false, but the effort to test them and to prove their falsity

leads closer to the truth. It is by setting up and testing hypotheses that the scientist makes discoveries.

To shut out the use of imagination in nature study is doing violence to a child's nature, for all his thoughts naturally assume imaginative forms in early years. But how flat and insipid would any nature study be which tries to bind down a child's thought to what is manifest to the senses! He can't see the plant grow. He only sees that changes have taken place and reason and imagination must help him to the rest. It is on the poetic and esthetic side that nature makes its strongest appeal to children. Many of the greatest poets have been the closest and most faithful observers of nature. Goethe, the Shakespeare of the Germans, ranked among the greatest scientists. Emerson, Burroughs, Thoreau, and Bryant are poets of nature, and observers also in the sense in which we wish to see children trained to observe.

It is certainly the business of nature study to teach children to observe accurately and to have an honest respect for the facts, but in reaching forward to the laws and unities, in interpreting the phenomena of organic and of inorganic matter, the imagination is indispensable. Facts and observations are often only stepping stones to the child's thoughts, the scaffolding by which it constructs the higher forms. Figures of speech and

poetic analogies, which both teachers and pupils use so often are the very soul of good instruction in natural science as well as in other studies. As Burroughs studies the birds, his imagination puts a human sympathy into their lives which is better for children than the facts and skins delivered to us by the dissecting knife and the taxidermist's skill. Science study is something more than a collection of lifeless memoranda.

Some primary teachers seem to outdo the children in finding sentimental and fanciful resemblances in nature. They deal in baby-talk and strain after impersonations and fanciful analogies. This is only a good thing carried to a ludicrous extreme. But any one who walks with children among birds and trees and butterflies will be taught to appreciate their impersonations and fanciful descriptions, for these are based upon the apperceiving experiences of the children. The exact technical terms of science are unknown to the children and should not be forced too soon upon them. They describe with much originality and acuteness and nearly always in figurative phrases.

Professor Tyndall, in his essay on the Scientific use of the Imagination, treats this subject as follows: "How, then, are those hidden things to be revealed? How, for example, are we to lay hold of the physical basis of light, since, like that of life itself, it lies entirely without the

domain of the senses? Now, philosophers may be right in affirming that we cannot transcend experience. But we can, at all events, carry it a long way from its origin. We can also magnify, diminish, qualify, and combine experiences, so as to render them fit for services entirely new. We are gifted with the power of imagination, combining what the Germans call *Anschauungsgabe* and Einbildungskraft, and by this power, we can lighten the darkness which surrounds the world of the senses.

"There are tories even in science who regard imagination as a faculty to be feared and avoided rather than employed. They had observed its action in weak vessels, and were unduly impressed by its disasters. But they might with equal justice point to exploded boilers as an argument against the use of steam. Bounded and conditioned by co-operant reason, imagination becomes the mightiest instrument of the physical discoverer. Newton's passage 'From a Falling Apple to a Falling Moon,' was a leap of the imagination. When William Thomson tries to place the ultimate particles of matter between his compass points and to apply to them a scale of millimeters, it is an exercise of the imagination. And in much that has been recently said about protoplasm and life we have the outgoings of the imagination, guided and controlled by the known analogies of science. In fact,

without this power our knowledge of nature would be a mere tabulation of coexistences and sequences. We should still believe in the succession of day and night, of summer and winter; but the soul of force would be dislodged from our universe; causal relations would disappear, and with them that science which is now binding the parts of nature to an organic whole" (Half Hours with Modern Scientists, p. 250).

BOOKS AS AN AID TO SCIENCE TEACHING.

PERHAPS the chief difficulty in the way of good science work in the grades is the poverty of science knowledge on the part of teachers. It is not a fault with which teachers are to be upbraided so much as a natural result of our usual course of study in the past. Even what science knowledge teachers have acquired in high schools and other advanced courses of study is not only inadequate but often unsuitable to the instruction of children. In all the higher schools there is, or has been, a strong tendency to system and classification, and not sufficient detailed study of particular forms and life histories. such as arouse the interest and observation of children. The usual text-books in natural science are extremely inadequate to prepare teachers for the instruction of children. They do not contain the right sort of material to serve as topics in the grades, even if the work is experimental or in field excursions.

Books of science are very important in the training and preparation of teachers for their work in classes. They do not take the place of personal observation, experiment, excursion, use of instruments, collections, in short, direct con-

tact with nature in a multitude of ways; but books are a great help to teachers in guiding their observations and in suggesting important centers and ways of observation. From books the teachers get direct stimulus and suggestion where to look and what to look for, and then they have sufficient start in the right direction to be left to their own resources.

The different books helpful to teachers' work may be classified as follows:

1. Text-books and classified books of science.
2. The masterpieces of scientific literature, as works of Darwin, Huxley, etc.
3. Monographs on science topics which give much fuller treatment to important type studies than text-books, *e. g.*, Scudder's Butterfly.
4. Books of inspiration for nature study, as for example, Burroughs's works.
5. Books of professional character discussing the principles and methods of science teaching, as for example, Jackman's Nature Study.
6. Science readers for the grades, primarily designed for children, but containing often materials helpful to teachers.

These six classes of books are helpful to teachers in different ways, somewhat as follows:

1. The text-books give the scientific or classified form in its general outlines. Through his previous studies they are familiar to the teacher and serve as a basis for his own systematic grasp

of his subject. These are excellent reference books and serve as a standard for a final grouping of observations.

2. By means of the masterpieces of scientific literature we are able to keep abreast of scientific thought. The schoolmaster must not fall far behind the more recent developments of scientific knowledge. Otherwise he will be teaching what scientists regard as exploded theories. Moreover, the great writers like Darwin, Agassiz, Gray, Tyndall, Haeckel, Lyell, and their like are the most stimulating and broad-minded in their influence. It is of very great advantage to come in contact with the masters of any science.

3. Perhaps the most helpful books to teachers are the monographs on particular topics. They alone make it possible for the teacher to equip himself thoroughly for the teaching of particular topics.

We have by far too few good monographs. Such are:

"The Oak," by H. Marshall Ward. D. Appleton & Co., New York.

"Spiders, Their Structures and Habits," by J. H. Emerton. S. E. Cassino, Boston.

"Sunshine," by Amy Johnson. Macmillan & Co.

"The Cray Fish," by Huxley. D. Appleton & Co.

"Ants, Bees, and Wasps," by Sir John Lubbock. D. Appleton & Co.

"On Forms of Water," by John Tyndall. D. Appleton & Co.

"The Story of the Hills," by H. H. Hutchinson. Macmillan & Co.

"Romance of the Insect World," by L. N. Badenoch. Macmillan & Co.

Boys and Girls in Biology." Stevenson. D. Appleton & Co.

"Home Studies in Nature." Treat. American Book Co.

"A Year with the Trees." Flagg. Educational Publishing Co.

"The Great World's Farm." Gaye. Seeley & Co., London and Boston.

"Simple Experiments for the School Room." Woodhull. E. L. Kellogg & Co., New York.

"Starland," by Robert S. Ball. Ginn & Co., Boston.

"The Oyster, Clam, and Other Common Molusks." Hyatt. D. C. Heath & Co.

"Worms and Crustacea." Hyatt. D. C. Heath & Co.

"The Builders of the Sea." Dodd, Mead & Co., New York.

"Seaside Studies in Natural History." Agassiz. Jas. R. Osgood & Co., Boston.

"Moths and Butterflies." Ballard. G. P. Putnam's Sons, New York.

"Our Common Insects." Packard. Estes & Laureat, Boston.

"Insecta." Hyatt. D. C. Heath & Co.

"Life and Her Children." Buckley. D. Appleton & Co.

"Jelly Fishes, Star Fishes, and Sea Urchins." Romanes. D. Appleton & Co.

"Vegetable Mould and Earthworm." Darwin. D. Appleton & Co.

"Fermentation of Vegetable Mould." D. Appleton & Co.

"The Sun." Young. D. Appleton & Co.

"The Fairy Land of Science." A. B. Buckley. D. Appleton & Co.

"Our Native Ferns and their Allies." Underwood.

"Trees of the Northern United States." Apgar. American Book Co.

"Wonders of Plant Life." Herrick. G. P. Putnam's Sons.

"Chapters in Modern Botany." P. Geddes. Chas. Scribner's Sons.

"Climbing Plants." Darwin. D. Appleton & Co.

"Butterflies." Scudder. Henry Holt & Co., New York.

"Science for All." Five volumes. Cassell. Petter, Galpire & Co., New York.

SCIENCE FOR ALL is a cyclopædia of natural science, in five volumes, containing many excellent chapters or monographs on special topics.

"A Naturalist's Rambles About Home." Abbott. D. Appleton & Co.

"Homes Without hands." Wood. Longmans & Co.

"The Weather." Abercromby. D. Appleton & Co., New York.

"The Horse." Flower. D. Appleton & Co., New York.

"Wild Beasts." Porter. Charles Scribner's Sons, New York.

"Volcanoes." Judd. D. Appleton & Co., New York.

"The Jack Rabbits of the U. S.," U. S. Department of Agriculture, Washington, D.C.

"Dust and Its Dangers." Prudden. G. P. Putnam's Sons.

"The Geological Story Briefly Told." Dana. Ivison, Blakeman & Co., Chicago.

"Agassiz's Geological Sketches." James R. Osgood & Co., Boston.

"A Song of Life." Morley. A. C. McClurg & Co., Chicago

"Science Sketches." Jordan. A. C. McClurg & Co., Chicago.

It is this kind of detailed information which may stimulate the teacher to the most careful ob-

servations on his own part, and furnish him with a rich fund of accurate scientific knowledge. With children especially, this fullness of concrete detail is indispensable to insight and interest. It is exceedingly desirable that good, cheap monographs be multiplied upon all the important topics of natural science, and then teachers will be able in large measure to help themselves. They do not take the place of observation, but greatly assist it.

4. Among the best books for both teachers and pupils are those of such writers as Burroughs and Thoreau, who create a great love for nature in plant, animal, insect, etc., and at the same time suggest the closest methods of observation. Burroughs's "Birds and Bees" is now quite commonly used as a reader in many schools. The classic form of these writers adds much to the charm of their studies. But it need not be supposed that classic form is any substitute for the true scientific spirit, but only the best channel through which the scientific spirit may flow. We have a large number of charming books, which breathe the spirit of the most sympathetic and appreciative study of birds and insects and plants in the open air. Such is

Burroughs's "Wake Robin." Houghton, Mifflin & Co.

Thoreau's "Succession of Forest Trees," and "Wild Apples." Houghton, Mifflin & Co.

Burroughs's "Sharp Eyes." Houghton, Mifflin & Co.

"Birds Through an Opera Glass," by Florence Merriam. Houghton, Mifflin & Co.

"Madam How and Lady Why." Kingsley. Macmillan.

Kingsley's "Water Babies." Ginn & Co.

"Up and Down the Brooks," by Mary Bamford. Houghton, Mifflin & Co.

"Inmates of My House and Garden," by Mrs. Brightwen. Macmillan.

"The Stories of the Trees," by Mrs. Dyson. Thos. Nelson & Sons, N. Y.

Winchell's "Geological Excursions." S. C. Griggs, Chicago.

"In Birdland" and "Birddom." Keyser. A. C. McClurg.

"The Foot-Path Way." Bradford Torrey. Houghton, Mifflin & Co.

"Little Brothers of the Air." Olive Thorne Miller. Houghton, Mifflin & Co.

"The Bird Lover in the West." Olive Thorne Miller. Houghton, Mifflin & Co.

These books are good companions for those who wish to study nature in the open air. They are especially valuable for the moral and esthetic attitude of mind that they cultivate, for the humanizing and protecting gentleness with which they observe animal and plant life. This counteracts the naturally thoughtless, wasteful, and destructive habits of children. The tree or a flowering plant has a life not to be wantonly destroyed. The robins and sparrows have anxieties and rights which the school-boy should respect. The esthetic sense, the appreciation of delicacy and beauty of form and color and motion in the things of nature, the whole esthetic taste and

appreciation, are matters of slow development and some of the classic writers just mentioned are well able to open our eyes to these best influences of nature study.

5. Teachers also need professional books which deal wisely with the problems and difficulties of science instruction. So rapid has been the development of science teaching in late years that we have but few manuals of science teaching that are abreast of the times.

It is to be hoped that we shall soon have a number of good hand-books of this sort for teachers:

Jackman's "Nature Study." Henry Holt & Co., New York.

"An Outline of Nature Study," by Charles B. Scott, Oswego, N. Y.

"Directions for Teaching Geology," by Shaler.

"Systematic Science Teaching." Howe. D. Appleton & Co.

"Number Work and Nature Study." Jackman. Published by the author.

"Moral Teaching of Science." Buckley. D. Appleton & Co.

"A Short History of Natural Science." A. B. Buckley. D. Appleton & Co.

"The Advance of Science in the Last Half Century." Huxley. D. Appleton & Co.

"Science Teaching in the Schools." W. N. Rice. D. C. Heath & Co.

"One Hundred Lessons in Nature Study." Payne. E. L. Kellogg & Co., New York.

"Elementary Biology." Boyer. D. C. Heath & Co.

"First Steps in Scientific Knowledge." Paul Bert. J. B. Lippincott & Co., Philadelphia.

"Twenty-five Years of Scientific Progress." W. N. Rice. J. Y. Crowell & Co., N. Y.

"Scientific Culture and Other Essays." J. P. Cooke. D. Appleton & Co.

"Recreations in Botany." Caroline Creevey. Harper Brothers.

Agassiz's "Methods of Study in Natural History." James R. Osgood & Co., Boston.

"Microscopy for Beginners." A. C. Stokes. Harper & Brothers, N. Y.

"Birds Nesting." Ernest Ingersoll. George A. Bates, Salem.

"The Naturalist's Assistant." J. S. Kingsley. S. E. Cassino, Boston.

"The Naturalist's Guide." C. J. Maynard. S. E. Cassino Boston.

The above illustrate what is needed. Courses of nature study must spring out of these discussions of the aim, selection of topics, and method of treatment of the same in different grades. The vast extent of the scientific field, the close relation of science topics to other studies, and the scientific and pedagogical method of treatment, are all deeply involved in this discussion, and the next few years will doubtless see very great progress in this field of pedagogic study and experiment.

6. In the last few years a large number of science readers for use in the grades for supplementary reading has been offered to the schools by different publishers, such as:

"Seaside and Wayside," Nos. 1 to 4. D. C. Heath & Co.

"The Child's Book of Nature," in three parts. Hooker. Harper & Brothers.

"A Botany Reader," two parts. Ginn & Co.

"My Saturday with a Bird Class." D. C. Heath & Co.

"Nature Stories for Young Readers," two parts. D. C. Heath & Co.

"Chapters on Plant Life." American Book Co.

"Brooks and Brook Basins." D. C. Heath & Co.

"Little People and their Homes." Charles Scribner's Sons.

"Natural History Readers." Wood. Boston School Supply Co.

"Wings and Fins," "Feathers and Fur." American Book Co.

"Boys and Girls in Biology." D. Appleton & Co.

"Little Nature Studies for Little People."

"Animal Memoirs," in two parts. Ivison, Blakeman Co.

"The Story of our Continent." Shaler. Ginn & Co.

"Glimpses of the Animate World." Johonnot. American Book Co.

And many others may be added.

It is a serious question to determine just what is the value of these science readers. It should first of all be clearly understood that they do not take the place of observation and real nature study. They should follow rather than precede the oral lessons, excursions, collections, and class study. After children have been introduced by observation and class instruction to important topics it may prove valuable to use the supplementary readers to enlarge and define more closely their scientific knowledge. Science read-

ers, however, are to be regarded as books of instruction for purely supplementary and private reading, rather than as text books for regular reading exercises. The regular reading lessons should be devoted to the appreciative study and rendering of American and English classics. Books of information, whether from science, history, or geography, are not good enough to serve for the purpose of the standard reading exercises. Many of the science readers, however, will prove quite helpful to teachers in supplying them with a part, at least, of the necessary scientific knowledge. Larger, more complete scientific treatises, are, of course, better; but most teachers have neither the time nor the money to spend upon the larger, complete books of science.

THE SELECTION OF TOPICS.

IN SELECTING and arranging the science topics for the first four grades the guiding ideas kept in mind are as follows:

1. Living animals and plants are observed. Not only the appearance, habits, and organs, but the whole life history is, at least, drawn upon.

2. Objects taken from the home neighborhood are deemed the best.

3. The season of the year will determine the time and opportunity for treating many topics.

4. Science topics prominently suggested by the stories, myths, reading, or geography lessons may be found well suited to the requirements of the science work.

5. The best types should be chosen, not for the purpose of premature classification, but because they furnish just as good concrete material for observation, and they also serve later as a basis for good comparison and simple grouping into classes.

6. There is no intent to limit the observations of children to this list of objects, but to suggest a series of important illustrative topics which may give definite plan and purpose to regular observation. Upon excursions and in discussions many

other science objects may be brought in and treated more or less fully. Such a course of study can be only suggestive, for no two neighborhoods are the same, and probably the same teacher in one locality would be inclined to vary his topics from year to year.

OUTLINE OF TOPICS FOR FIRST GRADE.

FALL TERM.

PREPARATION of familiar trees bearing large buds, for winter rest, *e. g.* hickory, buckeye, cottonwood, and balm of Gilead. This study is associated with gathering of autumn leaves.

Life histories of dog and cow.

Sheep—compare with cow.

Fox or gray squirrel—its home life.

Rabbit and mouse—compare with fox squirrel.

WINTER TERM.

Winter study of Austrian pine—a type of evergreen trees.

Scotch pine, hemlock, and Norway spruce—compare with Austrian pine.

Life histories of horse and chicken. The chicken studied as type of birds.

English sparrow and chickadee—Compare with chicken.

Life of the cat.

SPRING TERM.

Plant lima beans, sweet peas, and nasturtium seeds. Watch development.

Spring study of evergreen trees studied in the winter.

Robin and red-headed woodpecker.

Buds, blossoms, and fruit of apple, cherry, and plum trees.

Duck—type of water birds.

Goose. Compare with duck.

(The children draw the objects studied.)

References.—For study of quadrupeds see Dr. Lockwood's "Animal Memoirs," Part I.

For special study of gnawers see Standard Natural History, pp. 68-133; Seaside and Wayside IV; Johonnot's "Feathers and Fur," Johonnot's "Claws and Hoofs," Wood's "Homes Without Hands," "A Naturalist's Rambles About Home," Mammals of North America (Baird).

For study of trees see Mrs. Dyson's "Stories of the Trees," Apgar's "Trees of Northern United States," Gray's "Structural Botany," and Gray's "Physiological Botany."

For study of chicken see Dr. Lockwood's "Animal Memoirs," Part II.

For study of English sparrow see Olive Thorne Miller's "A Bird Lover in the West';' John Burroughs's "Locusts and Wild Honey," "Pepacton," "Riverby," and "Signs and Seasons;" Leander Keyser's "Birddom;" Parkhurst's "Birds' Calendar;" and "The English Sparrow," U.S. Department of Agriculture.

For study of robin see Dr. Lockwood's "Animal Memoirs" II; Parkhurst's "Birds' Calendar;" Torrey's "Footpath Way" and "Birds in the Bush;"

Miller's "Little Brothers of the Air" and "A Bird Lover in the West;" Burroughs's "Wake Robin," "Riverby," "Pepacton;" Keyser's Birddom" and "In Bird Land;" "The Youths' Companion Supplementary Reading Book," No. 7.

For study of chickadee see Burroughs's "Wake Robin," "Riverby," and "Signs and Seasons;" Keyser's "Birddom" and "In Bird Land;" Torrey's "Birds in the Bush" and "Footpath Way;" and "Birds' Calendar."

For study of red-headed woodpecker, see "Little Brothers of the Air;" "A Bird Lover in the West;" "Birddom;" "In Bird Land;" "Birds in the Bush;" "Wake Robin;" "Animal Memoirs," Part II; Bulletin 7 U. S. Department of Agriculture; "Farmer's Bulletin," 54 U. S. Department of Agriculture; and Youth's Companion Supplementary Reader No. 7.

For study of duck see Johonnot's "Feathers and Fur."

For study of seeds and flowers see Jane Newell's Botany; Goodale's "Concerning a Few Common Plants;" and Margaret Morley's Seed Babies,- 'Flowers and their Friends," and "A Few Famil" iar Flowers."

OUTLINE OF TOPICS FOR SECOND GRADE.

FALL TERM.

CONTINUE study of lima bean, sweet pea, and nasturtium.

Finish study of apples and plums begun the previous spring.

Metamorphosis of cabbage butterfly. If taken at the very beginning of the term the eggs may be found and all changes watched until the butterfly comes out.

Metamorphosis of milk-weed caterpillars and other caterpillars which the children may find.

Grapes and raisins (study of the ripening grapes on the vine).

Pumpkins, squash, and melons studied from flower to fruit.

The turtle.

Preparation of plants and animals for winter.

WINTER TERM.

Parrot (if the bird can be seen by the children).

Crow and owl. Compare with the parrot.

History of snow crystals.

Salt and sulphur crystals.

Quartz crystals.

Kinds and formation of pebbles and stones.

Watch for and note time of return of spring birds.

Watch for pussies on the willow. Notice the first changes in the buds of this tree, and of its mate which bears the seeds. Notice all succeeding changes in both trees.

Watch for changes in buds of linden, larch, and birch.

Goat. Compare with the sheep.

Simple process of butter and cheese making.

SPRING TERM.

Continue study of willow, linden, larch, and birch until end of term or until seeds have ripened.

Plant pumpkin, squash, melon, and morning glory seeds. Watch growth and changes.

Grapes—buds, blossoms, and green fruit.

Bluebird and brown thrush.

Violet and wild rose.

Frogs and toads. Watch development from eggs.

(The order in which these objects are studied is determined largely by the time of their appearance.)

BOOKS FOR REFERENCE.

For study of trees and flowers see books already referred to under First Grade work.

For study of squash, see "How a Squash Plant Gets Out of the Seed," "Teachers' Leaflets on Nature Study," Cornell University.

For study of parrot, see "Cyclopædia of Com-

mon Things," pp. 444 and 445; Anderson-Maskel's "Children with the Birds, p. 265; Johonnot's "Wings and Fins," p. 221; "Standard Natural History," vol. 4, p. 319; "Johnson's Natural History," vol. 2; "Museum of Natural History," vol. 2.

For study of moths and butterflies see Ballard's "Moths and Butterflies," Scudder's "Butterflies," and Mrs. Tenney's "Pictures and Stories of Animals," vol 4.

For study of birds, in addition to the books mentioned for reference in First Grade, see also "The Common Crow," "Some Common Birds in their Relation to Agriculture," "Hawks and Owls from the Standpoint of the Farmer," U. S. Department of Agriculture.

For study of crystals and pebbles, see Shaler's "First Book in Geology" and "Cyclopædia of Common Things," pp. 497, 518, and 572.

For study of toads' and frogs' eggs, see "The Life History of the Toad," "Teachers' Leaflets on Nature Study," College of Agriculture, Cornell University; Margaret Morley's "Song of Life" and "Seed Babies;" Jane Andrews' "Stories Mother Nature Told Her Children," and Mrs. Tenney's "Pictures and Stories of Animals," No. 3.

ILLUSTRATIVE LESSONS FOR PRIMARY GRADES.

This series of nature lessons for primary grades was worked out by Mrs. Lida B. McMurry and used in those grades.

THE SHEPHERD DOG.

(Suggested by the story of "The Old Woman and Her Pig.")

To what did the old woman first go for help when her pig would not go? (To a dog.) Why should she go to a dog? (Dogs help to drive pigs.) Did you ever see one driving pigs, cows, or sheep? How did it drive them? (Trotted along behind them; if one lagged or went out of the way, the dog barked at it or jumped at it, snapping his teeth; if the animal paid no attention to this, the dog did what the old woman wanted the one in the story to do.) What was that? (Bite.) These dogs do not bite hard, usually.

How many have ever seen a dog driving sheep? What do we call a dog that cares for sheep? We shall talk about shepherd dogs and see how useful they are.

Who in the class has or knows a shepherd dog? Does it know much? How do you know? (Children relate what they know of this species of dogs, the teacher telling stories from her own experi-

ence or such as she has read, illustrating their sagacity.)

When I was a little girl my father owned a shepherd dog, named Prince. We were all very fond of him. Our home was a long, long way from any neighbor, and in the daytime our sheep grazed on a great pasture which was as large as this whole town. This was a queer pasture, you will think, when I tell you that there was no fence at all around it, and when we spoke of it we called it a prairie. Every morning Prince would help my father drive the sheep to this prairie. A place was found where the grass was good, and here the sheep would spend the day. One of their number wore a bell, and through the day we could hear the distant tinkle of the bell. If for any length of time we failed to hear it, some one went with Prince to the prairie to see what was the matter.

At night my father would call Prince and say, "Prince, bring up the sheep," and away he would trot, alone, the very instant he was told to go. He gathered his flock together, and drove them home. If any sheep was hurt or sick so it could not go, Prince, after trying to get it along, would leave it and drive home the others. He knew just how fast the sheep could go without becoming tired out, and no matter how many rabbits ran across his path, he never left the sheep to chase the rabbits, though he enjoyed nothing better

when by himself. On reaching home, had a sheep been left behind, Prince would go to my father, look up into his face, bark, and start toward the prairie. We always knew from this that something was wrong, so father would follow Prince and get the poor sheep home.

Our cattle were kept in a fenced pasture. One Sunday, on returning from church, we saw that some strange cattle had broken into this pasture and were grazing with our own. The gate of the pasture was opened and Prince told to "drive them out." He knew our own cattle well, and we all watched him as he went into the herd, picked out one by one the strange cattle, and drove them to the gate.

How do you think Prince could tell which cattle were not our own? (He had sharp eyes.) Have the shepherd dogs that you know sharp eyes? Why do you think so? Of what color are their eyes? Do all the dogs which you know have eyes of this color? Do the little puppies have brown eyes? Are the shepherd dog's eyes larger or smaller than your own? Of the same shape? Are they in the same part of the face as your own? Tell me what you have learned about the shepherd dog's eyes.

But when Prince started out for the sheep, was it his eyes that told him where they were? (No, he could not see them.) How did he know where they were? (He might have heard the

bell.) Could he hear well, do you think? Do your dogs hear well? (Children relate their experiences.) What does your dog do first when you call him? (Pricks up his ears.) Why? (So that he may catch all of the sound that he can.) Can you prick up your ears? (Our ears stand out so that we can catch the sound easily without moving them.) Where does the sound which he catches go? (Through the openings in the side of his head.) Did you ever look into these openings? Do flies, bugs, dust, etc., go through these openings? What is to hinder? (Shepherd dogs' ears droop over this opening, and hair covers it largely.) How is it with your ears? What keeps insects out? Where on the dog's head do you find his ears? Are they higher up or lower down than our own? How many ears has he? Why does he need two?

Tell me now all you can about a shepherd dog's ears.

But Prince sometimes could neither see nor hear the sheep, yet he started off in the right direction. How did he know where to go? He might have remembered. But if he had not remembered, quite likely he could have found them. Have you ever seen a dog that was lost from his master? What did he do? (Put his nose down close to the ground.) Why? (To scent the tracks of his master.) Can your shepherd dog smell well, Archie? Does his nose look as if he could?

(Yes, it is long, and pointed, and has large holes.) We call these holes nostrils.

Now, tell me how a shepherd dog might find the sheep when he could neither see nor hear them.

Prince had to go for the sheep in rainy as well as in pleasant weather. He had no rubber coat or umbrella. How did he keep off the rain? (He had a good hair coat.) Was it a good one? (Yes, shepherd dogs have thick hair all over the body.) What did he do with his coat in pleasant weather? Of what use was it to him then? (Kept him warm.) Did he wear such a coat in summer? Why? (To help keep bugs, flies, etc., from biting him.) Is not the winter coat too thick for summer? What is done about it? How do you know? (We do not like to handle the dog or have him in the house in the spring and summer when he is shedding his coat.) Is the hair next the body like that on the outside? Do you think this is well for the dog?

Is a shepherd dog's hair the same length all over his body? Why shorter on the legs? Why on the face? Are there any bare places on his face? Do the flies ever bother him here? How does he get them off? (Shakes his head or brushes them off with his paw. Sometimes he sleeps with his paw over the end of his nose.)

No matter how fast Prince ran, his coat never looked wet with sweat. Did you ever think of it —that your dogs do not sweat as do horses, or as

you do? How do you think Prince showed that he was very warm? (He hung out his tongue: something that looked like water ran off from it.) Do you suppose that this cooled him off? Put your finger in your mouth, then hold it up in the air a minute. What happens? (It gets cold.) What happens when the wind blows on the dog's wet tongue? (It cools him.)

What is the color of the coat of a shepherd dog? Prince's coat was black, with a white collar, a white star in his forehead, and white toes.

You may tell me, now, all you can about a shepherd dog's coat.

The road over which Prince went was a rough one; quite stony, too, in one place. Should you think his feet would become sore? Do the bottoms of his feet touch the ground as do yours when you walk? [Have a shepherd dog in the class if possible; if not, another dog will do.] What part touches the ground? (Only his toes and the ball of his foot. He walks all the time as we do when going on tip-toe.) On how many toes does he walk? Look at the dog's foot. Picture one of the front feet, also one of the hind feet. Has the dog a toe answering to your thumb? Point to it. One answering to your big toe? Point to it. Where are his heels? Feel of them. Some child, quite likely, may have on low shoes. Call attention to the great tendon of Achilles which

lifts the heel. Where do we find this in the dog's hind legs? Where is his heel?

Look at these toes on which the dog walks. Feel of the part that touches the ground. (It is almost as tough as leather Each toe and the ball of the foot has a cushion with a very thick cover.) Do you think that the stones hurt Prince?

Does the dog make much noise in running? Why not? Listen as he runs over the floor. What do you hear? Now you may tell me all you can about a shepherd dog's feet.

When Prince came home at night we used to pet him. In what way, do you think? Do you think he liked to be petted? How would he show that he liked it? What was he telling us?

In what other way do you think we showed that we cared for him? (Gave him a good dinner.) What do dogs like best to eat? How do they eat the meat? (Swallow large pieces without chewing. They sometimes hold the meat down with their front feet, or hands, while they pull off pieces of it.) What part do they eat that we never eat? (Bones.)

[Bring a gentle dog to the class and examine its teeth, if the jaw of a dog cannot be procured.] What are these long, sharp teeth for? Have you such teeth? Show me that you have. Are they longer or shorter than those of the dog? What are these smaller front teeth of the dog for? How many? Have you such teeth? Where? With

what teeth does it chew the bones? Are they good teeth for that?

What do dogs do with bones left from a meal? (Bury them.) Where? How do they make the hole in which to bury them? Which claws do they use? What kind of claws does a dog need to dig with? (Strong claws.) Why? (So they will not break.) What shape must they be? Look at the Shepherd dog's claws and find if they are strong and slightly curved. How does he cover the hole? Notice carefully.

We also set a pan of water where Prince could get it. How did he drink it? Watch your dogs drink water and tell me just how they do it. Do dogs drink much water? How much at a time? Sometimes they suffer because their masters forget that they need water.

Not long after Prince had had his dinner he went to bed. What kind of a bed does a dog like? Did you ever watch a dog lie down in his bed? What does it do? Children report later, if not ready now.

Did you ever hear a dog talk? Prince was a good talker, after his fashion, and we could understand what he meant, usually. In what ways do you think he talked? (*a*) He growled when he did not like what he saw or heard. (*b*) He barked hard and long when he wished to drive animals away. (*c*) He barked short happy barks when he was glad to see us. (*d*) He whined when not al-

lowed to follow us into the house. (*e*) He snarled at any one who tried to get his food away from him, or at a tramp. (*f*) He howled when left at home alone. (*g*) He yelped when he was hurt.

He had a way of talking, also, without making a sound. How was that? (By his tail.) What did his tail tell? (When he wagged his tail it told us that he was pleased, or that he thought we were going to give him something that he liked. Dogs wag their tails just before they "speak." When he was frightened, or ashamed, he carried his tail down between his legs.)

The children might review the whole subject of shepherd dogs by going with Prince after the sheep.

Do you think shepherd dogs are useful? What have we found that they can do? What other helpful things have you seen them do?

Other species of dogs familiar to the children may be studied by comparison with the above, thus:

What other kind of dogs do you know? Ralph has a rat-terrier. How many have seen one? (Probably all.) How does a rat-terrier help us? (Catches rats.) How is it that he can catch rats better than a shepherd dog can? (*a*) He is much smaller. How does this help him? He can go under piles of rubbish and into holes where a shepherd dog could not go. (*b*) He is quicker in his movements. How does this help? (A rat runs

fast. A dog must be very quick to catch it.) (*c*) His teeth are smaller, and so, sharper than those of a shepherd dog. (*d*) His hair is straight, short, and stiff, and lies down close to his body, so he can get into holes more easily than the shepherd dog with long, thick, curly hair.

Children make a drawing of the shepherd dog.

AUTUMN LEAVES AND BUDS.

As soon as the leaves begin to fall, encourage the children to bring beautiful ones to school, the teacher pressing some of them for the decoration of the school room. Ask the children to name the trees from which the leaves come. Notice what tree first puts on gay colors, and have the children note carefully the succession.

The trees that wear yellow dresses may be grouped together, also those that wear dresses of red, purple, spotted red and yellow, etc. Do all trees that send off their leaves, dress them beautifully before they go? What trees have leaves that shrivel up when the frosts come?

You have had a story about a little leaf that worried a great deal—The Anxious Leaf. About what did it worry? (For fear the wind would pull it off and throw it down on the ground to die.) Is the wind doing that with any leaves now? Do they fall easily? Could the wind always pull the leaves off so easily? (No, not in the spring and summer.) You may shake the little branch that

I brought in. (The leaves come whirling down.) Let us see if we can find out why the leaves fall so easily now. Why is it, do you think? ("They forget to hang on." "They are loose." "Something is growing up between the leaf and the branch and the leaf can't reach around it.") Look closely at that something. What is it? (A tiny bud.) Will it fall off? Why do you think it will not? (It holds on so tightly.) Do you think it liked to have the leaf by it? (Yes, the leaf put its arms around it and kept it warm, and dry, and out of the sight of bugs which might eat such a little thing.) It is true that the buds need the leaves when they are so tiny, but they do not push the leaves off. Notice carefully these leaves on the branch. Here is a little fence which has been slowly built up between the leaf and the branch. When the fence is done the leaf drops. But this fence is never built up too fast. The leaves, all through the summer, are working away, for they prepare all the food which the tree needs. When the little fence is begun the tree ceases to eat much and so stops growing. Instead of using the food prepared by the leaves, it packs it away in its trunk and branches, for it will need it in the spring, and when the leaves have furnished the tree all the food it needs their work is done and they are ready to go, and just at that time the fence is finished.

[This is probably as deep as we shall care to

go into the subject with the little children who have just entered school.]

You have spoken of the leaf caring for the bud. Why should it care for it so tenderly? Of what use is a bud? Let us see what is in this little cottonwood bud. (The outside is sticky.) Why is that? (To protect it from the rain and snow and to keep bugs from eating it.) We will take off this waterproof coat very carefully. What do you see here? What do these coats do? (There must be something very fine inside which these coats are keeping safe.) And inside these soft wrappings what do we find? (Some tiny leaves.) What are they doing here? (They are lying in their warm bed, cuddled closely together, waiting for spring. When the weather begins to get warm in the spring the wax on the outside will melt and the buds will throw off their covers and come out.) Why not come out now? (They would freeze in the winter, so the tree gives them very little food—just enough to keep them alive but not enough to make them grow.)

Open other buds, some will be found to contain flowers. Notice the difference in the shapes of the leaf buds and flower buds. [The flower buds on many trees are short and round, while the leaf buds are long and pointed.]

Was it not too bad for the leaf to leave the little bud? (No; the bud does not need it longer, it is covered up so well. The leaf stayed with it

until it had on all its covers, so the little buds do not need the leaves, and the tree does not need them to prepare its food. But would it do any harm for them to stay? (Yes, the snow might gather on the leaves and break the branches off with its weight.)

Do you think you would find buds on all these trees that are losing their leaves? Look and see, and find if all the leaves and flowers are wrapped up in the same way that those on the cottonwood are wrapped.

See Jane Newell's "Reader in Botany," I, for help; also Gray's "How Plants Grow."

It is advisable to center observation chiefly upon one or two kinds of trees, as hickory and cottonwood.

THE COW.

To what animal did the old woman (in the story of "The Old Woman and Her Pig") go last for help? (To the cow.) What did she want the cow to do for her? (Give her some milk.) But before the cow would give her any milk, she must do something for the cow. What was that? (Give her some hay.) How much did she give her? (An armful.) Is an armful of hay enough to last a cow all day? How many of my armfuls do you think it would take? Why does a cow need so much to eat? (She is large.) As large as a shepherd-dog? (Much larger. A shepherd dog could walk right under a good-sized cow.)

Where do the farmers get this hay that the cow likes? Do the cows ever get it from the fields themselves? When? Did you ever watch a cow eating grass? What did she do first? (Put her head down to the ground.) Could you do that? (Yes, if I could stand as a cow stands.) Do you think so? *How* does the cow stand? On what? Its toes, as the dog does? (No, it stands on the *nails* of its third and fourth fingers and toes.) What do we call these nails of the cow? (Hoofs.) Where are the nails on our fingers? (On the back of the ends of our fingers.) Where are the nails of the cow? (Her nails or hoofs go all the way around.) Feel of them. (They are very hard and thick.) Does she need such hoofs? Why? Notice the shape. (They look like one hoof cut in two.) Because they look this way, we say the cow has a *cloven* hoof. Cloven means cut in two, but we know that she has two nails or hoofs on each foot.

Now you know how the cow stands while she eats. How is it? Would any like to try standing as she does? (Can not do it.) Why not? (Our nails are not strong enough to bear our weight.) Does the cow have any trouble to stand? Can she reach the grass on the ground with ease? How does she gather the grass? (She reaches out with her tongue and draws a wisp into her mouth, and nips it off with her teeth.) What kind of a tongue has she, that can be used in this way? (A long, limber, rough one.) Why need to be long? Why

limber? Why rough? What else does she use in gathering the grass? (Her thick, broad lips.) [These answers should be the result of the child's careful observations.] How does she bite off the grass? (With her front teeth.) Have you noticed anything strange about these front teeth? (The cow has no front teeth in her upper jaw.) How then can she bite off the grass? (The upper front jaw is very hard, almost as hard as a bone.)

Does she eat rapidly? How long does she chew on a mouthful of grass? Does she keep on eating all day at this rate? (No, after a while she lies down, or stands and rests.) Did you ever notice how a cow lies down? Does she lie down as the dog does? What does she do first? Then what? If you watch her mouth while she is lying down or resting standing, what will you find her doing? (Chewing her cud.) What is this cud, and where does it come from? I will tell you. Where does your food go after you swallow it? (Into the stomach.) Now, a cow has a very large stomach. The grass which she bites off she chews but a little, if any. She swallows it, and it goes into a room in this big stomach, where it soaks for a while. Watch a cow's throat a little while after she lies down, and tell me what you see. (Something going up her throat toward her mouth.) This is a little of the soaked grass going up to be well chewed. We now call it a cud. What becomes of this cud? (After it is chewed up fine, the

cow swallows it and it goes into another part of this big stomach.) Then what? (Another cud goes up to be chewed in the same way, and so on.) Do the cow's jaws move as yours do when chewing? How do yours move? (The upper jaw does not move. The lower jaw moves chiefly up and down.) Do the cow's move in that way? (Her upper jaw does not move, but her lower jaw moves from one side to the other.) What does this sidewise motion of the lower teeth on the upper teeth do for the grass? (Grinds it up. It is her mill in motion.) Which teeth do the grinding? (The back teeth.) Let us see if they are good grinders. [Have jaw of cow if possible.] (They are broad, flat, and hard.)

Is it a good thing that the cow can pack away her food, and chew it when at rest? (Yes. She can gather grass in the cool of the day, then lie down in the shade when the sun is hot, and eat it. She does not have to stand as much as she otherwise would, but can rest while eating.)

In the winter time, what does the cow eat instead of grass? (Hay, straw, and fodder.) She eats these as she does the grass, *i. e.*, chews them slightly, swallows, then re-chews as a cud.

What beside grass, hay, and straw does the cow like to eat? (Corn.) How does she get hold of the ears of corn? How does she eat corn? What becomes of the cob?

What else does the cow like? (Oats, meal, and

bran.) How does she eat them? What is bran?

Can you think of anything else we feed the cow? (Carrot, turnips, beets.) How does she eat them?

Anything else? (Salt.) Do we salt the cow often? How does she eat it?

Can you think of something else she would want? (Water.) How often should a cow be watered? Does she lap up the water as the dog does? How, then, does she drink?

[All these answers made by the children should be the result of their own observations.]

Now, is there anything we can do for the cow in the summer, besides feeding her well? (Give her a pasture in which there are trees or a shed to protect her from the hot sun.) And in the winter, what? (Give her good shelter from the cold and snow, and a good straw bed at night.) But has she not a hair coat to keep off the cold and snow? (This coat helps, but it is not thick enough to keep her warm in bad weather.) Is it as thick as the shepherd dog's coat? Are the hairs of the same length as his? Are they as fine? Does she wear the same coat in summer and winter, or has she a lighter coat in the summer, as the dog has? How do you know? Is her coat the same color as that of the shepherd dog? We do not often see the cow's coat wet from sweating. When she gets warm, she opens her mouth, lolls out her tongue, and pants, much as the dog does.

In the winter you can see the steam coming from her great nostrils. Have you noticed these nostrils?

Where is the hair longest on the cow? (On end of tail.) What use does she make of this long brush? But she cannot keep the flies off her neck and shoulders, even with so long a brush. (She drives them off by tossing her head around.) How does she keep them off her feet and forelegs? (Stamps her feet.) Children speak of the trouble of milking cows in summer on account of flies.

Can you think of any other way she has of driving away things that bother her? Does she bark or bite, as the dog does? (She has horns to hook with.) [Have a horn in the class if possible.] Can she hurt with such horns? (Yes, the outside is very hard, and they are strong and sharp pointed.) From what part of the head do they grow? Is that a good place for them? Why do you think so? How does she use them? When? (Not so often to defend herself as to protect her calf. She is very fond of it.) Did you ever see her drive away dogs? How else does she show that she is fond of her calf? (She cries for it if it is taken away. She licks it with her tongue. That is the only way she has of kissing it. She stands still for it to get its dinner. Do you think the little calf pretty? What do you like about its looks? (It has pretty eyes for one thing; so has its mother.)

Children draw pictures of cow and dog side by

side. Draw from objects if possible. The teacher will lead the children to correct their own drawings by reference to the objects. Before drawing notice the form of each closely and compare so as to be able to draw them correctly.

We have found many things that we can do or the cow, now we shall see what she does for us. What does she give us night and morning? How do we get the milk? Which gives the more, the cow kindly cared for, or the cow poorly housed and fed? For what do we use milk? Do we get cream from the cow? Do you see it when she is being milked? (No, we only see the milk.) Where do we get the cream? (It rises on the milk.) What is made from cream? (Butter.) Tell me how butter is made. [If possible watch the process.] What is made from cream and milk? (Cheese and cottage cheese.) What else is cream used for? (Ice cream, etc.)

What other food do we get from the cow? What is the flesh of the cow called? (Beef.) Do we eat much beef? What do we call the beef w) use? (Steak, roast, soup-bones, dried beef, etc. Beef is also used in mince pies.

The flesh of the calf is called veal.

The fat of the cow gives us suet for puddings and mince pies. We also get tallow from the fat. From tallow, candles and wagon-grease are made. It is also used in making soap. Oleomargarine,

which takes the place of butter, is made from tallow.

Is the hair coat of any use to us? (Men put hair in plaster to hold it together.)

Does the thick undercoat keep *us* warm? (Yes, it is made into leather.) From the leather, boots, shoes, and shoe-soles are made. From the calf's coat, fine shoes are made.

What do the cow's horns give us? (Combs and knife handles.) Have these in the class for the children to look at.

The hoofs, too, are useful to us, for what? (They are made into glue.) (Have glue in class.) Show pieces of furniture glued together.

Even the bones of a cow are of use to us. For what? (Buttons and knife handles.)

You may tell me all the things the cow gives us.

Which now do you think is the more useful to us, the dog or the cow? (The cow.) But they are both our good friends.

A large product chart or collection of products can be made by the teacher and pupils; it adds greatly to the interest in the subject. Milk, cream, etc., can be sealed up in small bottles.

THE SHEEP.

(By comparison with the cow.)

What other animals, besides cows and calves have you seen grazing in pasture? (Horses and sheep.) Have all seen sheep? [If any are unfa-

miliar with them a visit should be made to one; or, better, to a flock. Perhaps some child may have a pet lamb, which, like Mary's in the poem, might follow him "to school one day." This would afford an excellent opportunity for close study.]

Watch the sheep as it eats grass. What does it do? How does it bite off the grass? (With its front teeth.) Look at these front teeth. [The children might do this at home and report the following day. They discover that the sheep has no teeth in the front part of its upper jaw.] What other animal have you found lacking teeth here? (The cow.)

See how long the sheep chews the grass before swallowing. What are these sheep over here doing? (Lying down and chewing their cuds.) What will these sheep that are eating so rapidly now, do by and by? What other animal eats grass in the same way? (The cow.) From what you know of the cow's cud, tell me how you think the sheep gets its cud? [Children review process of rumination in the cow. If this study is taken up in the winter time the children observe the sheep eating hay instead of grass.]

Which eats the grass off the shorter, the cow or the sheep? Why can the sheep do this?

Does the sheep eat corn in the same way that a cow eats it? [Children name any differences that they may have observed.] (A sheep nibbles

off the kernels.) Watch it and see how it does this. What else does it eat? Does it eat carrots, turnips, and beets, as a cow eats them? What difference? Does it hold the food down with its foot, as the dog sometimes does, when eating its food? How do sheep eat salt? How drink water?

Notice how lightly the sheep step around. Let us look at their little feet. What do you find? (They, like the cow, walk on their toe-nails—two on each foot.)

Did you ever think how much the cow and the sheep are alike? They surely must be cousins. Name those points in which they are alike.

(*a*) Both have cloven hoofs (walk on toe-nails).

(*b*) Both lack teeth in front part of the upper jaw.

(*c*) Both chew the cud.

Are they unlike in any ways? Look at the two as they graze side by side. How can you tell them apart? (The cow is much larger than the sheep. The sheep could run under the cow. The sheep is nearer the size of the shepherd dog.)

If both were of the same size could you tell them apart by their looks? (The sheep has a wool coat, the cow, a hair coat.) Is there any other difference in these coats, except that one is wool and the other hair? (The sheep's coat is usually white—occasionally brown—the cow's coat may be white, red, black, or spotted.) Is there not still another difference between the sheep's coat and

that of the cow? (The sheep's wool coat is much thicker than the cow's hair coat.)

Let us look closely at this wool coat. Have wool in the class. Each child may pick some to pieces and see if it is at all like the cow's hair coat. (It *is* hair, only the hairs are much finer than those of the cow, and they are wavy and seem to be fastened together, so that it is hard to pull them apart.) Stretch one of these fine hairs. What about its length, now? (It is much longer than it looks to be when on the sheep.) Does the wool lie down on the sheep's body in the same way that the hair lies down on the cow's body?

You have told me that the sheep and cow are unlike in size, and wear different kinds of coats.

If the sheep were the same size as the cow and wore the same kind of a coat, could you tel them apart? (Not many sheep have horns.) Do all cows have horns? (Many have none.) Could you tell them apart by the looks of their horns? Look at the sheep with horns and the cow with horns and see. (The cow's horns are round, quite smooth, and pointed. They usually start out from the head in opposite directions, then curve inward and forward so it can hook with them.) [Children show by drawing at the board.] The sheep's horns grow backward and downward, often forming a curl. They are not round, and are rough. [Children draw a sheep's head to show how its horns look.] Can you think why it

is well that the sheep's horns do not stand out in front of its head? (Sheep crowd close together in the fold at night, or when frightened, and sharp pointed horns such as the cow has would be apt to injure other sheep.)

How can sheep keep away their enemies with such horns, or no horns at all, as in most cases? [Children relate any experience of their own, or such as they have heard, of the terrible blow given by a sheep with its head, butting. The large horned sheep are usually willing to do the fighting for a flock. They are no cowards. The teacher might relate instances showing the bravery of the rams in defending a flock.] Have you ever noticed a mother sheep when a dog came near her lamb? What did she do to show her anger? (Stamped her foot.) And if the dog came nearer what did she do?

Then she can fight to save her baby from harm, even though she has no horns.

You may tell me again some difference between the sheep's horns and those of the cow.

In how many points have we found the sheep different in looks from the cow?

Now, if the sheep were like the cow in size, wore the same kind of a coat, and had the same kind of horns, could you still tell them apart? Look closely at the animals and see. (The end of a cow's nose is wide and bare.) Its nostrils are far apart. The sheep's nose is more pointed.

There is hair on the end of its nose, and its nostrils are quite close together

Let us name the difference in looks between the sheep and the cow. (*a*) The sheep is smaller than the cow. (*b*) It wears a wool coat, while the cow wears a hair coat. (*c*) The sheep's horns are different from those of the cow. [Children explain.] (*d*) Their noses are different. [Children explain.]

But I might be able to tell a sheep from a cow without looking at one. How? (By its cry. A sheep says, "Baa." A cow says, "Moo." We call a sheep's cry a bleat, and the cow's a low. When do we hear the sheep bleating a great deal? (In the spring when the lambs are little.) And how do the lambs answer their mothers' calls? The sheep bleat also when they are hungry or thirsty. So we can tell sheep and cows apart both by seeing and by hearing them. The scent of the sheep is also peculiar.

We found that the cow does a great deal for us. Is the sheep also our good friend? What does it do for us? (Its wool is made into blankets for our beds, warm shawls, cloaks, coats, etc.) (Children show garments made of wool.) How do we get it from the sheep? (Men cut it off with great sheep-shears.) How often? But is it not very dirty after being worn without change for a whole year? [Children tell about sheep washing which occurs a few days before the

shearing. If none have seen the process the teacher explains and shows pictures.] Then when their wool becomes dry, what is done? [Children who have seen sheep sheared explain how the coat is taken off, and how packed away. The teacher shows good pictures to those who have never seen this done. Show sheep-shears, explaining how they are worked.] An explanation of the making of wool into cloth is given later.

Did we use the outside coat of the cow? For clothing? For what, then? Which outer coat, that of the sheep or that of the cow, is of the more use to us? Do we use the under coat of the sheep—the hide? Is it of the same thickness as that of the cow? [Compare some pieces of pelts of each.]

Does the sheep need as thick an undercoat as the cow? Why not? (Its wool coat is so much thicker than the hair coat of the cow.) What is made from this thin undercoat of the sheep? (Leather out of which gloves are made and in which books are bound.) [Show articles made from sheep skin.] Do you think that it is as useful as the cow's undercoat?

What else does the sheep give us? (Its flesh to eat.) What do we call it? (Mutton.) Do we use its fat? What do we call it? (Mutton tallow.) For what is it used? (Candles, soap, and healing ointments and salves.)

Which does the most for us, the sheep, the cow,

or the shepherd dog? Which one do you like best for a pet?

Children draw a picture of cow and sheep side by side, if possible from objects. Lead them to correct their own mistakes in representation by reference to the real object.

A chart showing the products of the sheep might also be made.

THE RABBIT. (COMMON HARE.)

The purpose of the first recitation is to find out what the children know about the subject.

"Did you see some little tracks in the snow this morning as you came to school? What made them? (Dogs or cats.) Did you see any others smaller than these? What had made them? (Rabbits.) "Show me on the board just how these tracks looked. If the children can not do this, ask them to notice closely and draw a picture of them on paper and bring to class next day. When do you think the rabbit made them? (At night.) Why was he running around at night? (To get food.) Why not get his food in the day time? (He is afraid something will see him and catch him.) Then the rabbit has enemies, has he? Name some of the enemies that you know. (Men, dogs, cats, snakes, hawks, owls.) To-morrow we shall see how these tracks of Bunny's help some of his enemies to catch him.

At the next recitation the teacher brings in a

tame rabbit, introducing it as gray Bunny's cousin who hops just as gray Bunny does, and has ears and eyes much like his, except the color of the eyes. The teacher takes the pictures called for the day before. Explanations are made of how the rabbit makes the three tracks instead of four. The two front feet strike together, and the two hind feet come up on the sides, striking a little in front of the two front feet.

Which feet go first, the fore or the hind feet? Which pair of legs help him the more in hopping? (Hind legs.) How are they fitted for helping him so much? (They are long and strong.) What about the front legs? (They are shorter and weaker.) How is it that the rabbit can get around so quietly? I will hold him so that you may see if you can find out. (The soles of his feet are cushioned and covered with hair.) Why does Bunny need to get around so quietly? (So his enemies will not hear him.) But we have found out that when he hops he leaves what? (Tracks.) And we said yesterday that some of his enemies were helped by these tracks to catch him. What enemies? (Men. They see the tracks and follow them.) What other enemies are guided by the tracks? (Dogs.) How do the tracks help them? Did you ever see dogs hunting rabbits? What did they do? (Kept noses down to ground.) What doing? (Smelling the tracks—"getting the scent.") Do they need to see the tracks? (No.) Now what

will Bunny do to get away from the dogs? How will he know that they are coming? (See them.) Has he good eyes for seeing them? Look at them, where are they? (On sides of head.) How does that help? (He can see all around without turning his head.) What does he turn? (His eyes; so that when he is running he can see the dogs back of him.) What else tells Bunny that the dogs are coming? (His ears.) Are they good ears? Give a low bark in the next room, Earl. What did Bunny do? (Stuck up his ears.) Why? (To catch the sounds.) What else do you notice about his ears? (He can turn them in any direction.) How will this help him? (Even if he cannot see the dog he can tell from what direction he is coming without turning his head.)

Now that Bunny sees or hears the dog, what will he do? (Run.) Can he go fast? How do you know? (Have seen him.) (Those long, strong hind legs help him.) How does he hold his ears when running? (Down and back.) Why? ((*a*) So that they will be out of his way when running under fences and brush. (*b*) So that the air pressing against them will not hinder him. (*c*) So that he can hear his pursuers.)

In what other way can he get away from the dogs? ((*a*) He may glide into a hole or hollow log. (*b*) Turn suddenly when the dog gets up to him. The dog cannot turn so quickly, and not expecting this turn in affairs, loses some time, the

rabbit improving it in getting away. (*c*) Crouch down on a log or in the bushes. His color being very similar to that of the log or bushes, the dog will sometimes give up the search after sniffing around for a short time within a short distance of him.)

If Bunny escapes from the dogs he goes where? (To his home.) Where is it? (Near some log, under bushes, at foot of tree, or in the weeds.) What kind of a house? (A hollow in the grass or weeds.) Is there no roof to his house? (No.) Sometimes there is. What kind of a roof do you think it is? There is sometimes such a roof on your house, over the other roof. (Snow.) How did Bunny get such a roof? (Remained in his house, or *form*, during a snow storm and let the snow cover him.) Does snow make a good roof for him? Why do you have warm covers on your bed at night? (To keep us warm.) How does it keep you warm? Is not the cold air all around your bed? (The covers keep it out and keep the warmth in.) What does the snow do for Bunny? (Keeps cold air out and warmth within) How can he breathe in there? Did you ever breathe on the ice, covering the window, some cold morning? What did your warm breath do to the ice? (Melted it.) What does Bunny's breath do to the snow? (Bunny's breath melts the snow a little, so he can get fresh air.) How long will Bunny stay in his snow-covered home? (Till he gets hungry.) Is he safe from

his enemies now that the dogs haven't his tracks to scent? (No, he is not. The hunters are out.) Could they tell where Bunny is? How? Can you see your breath on a cold morning? What does the hunter see as he looks off over the snow? (Steam, coming from Bunny's home—his breath.) Why does the hunter want to kill Bunny? ((*a*) For food. (*b*) For his fur. (*c*) For fun. [What do you think of this?] (*d*) Because he eats the vegetables in summer. (*e*) He girdles the farmer's trees in winter.

Does it not seem that with so many enemies there would be no rabbits left? This would be true were there not so many young rabbits every year, enough to take the place of those killed.

We have learned something about Bunny's enemies. Why do gardeners and fruit raisers often kill rabbits? (Because they eat their vegetables in the summer and gnaw their fruit trees in the winter.) Why do they gnaw the fruit trees in the winter? (Food is scarce then and they like the bark of trees.) Would they gnaw young or old trees? (Young trees, because they have tender bark.) What kind of teeth must the rabbit have to gnaw this bark? (Sharp teeth.) Must all the teeth be sharp? (The front ones, at least, must be so.) What else should be true of the front teeth that they may nibble off the bark? (They should be long.) Why? (So his gums will not be injured by the wood of the tree.) Some-

thing else must be true of his teeth, also. Think of the kind of food he is getting and how he is getting it. (They must be strong.) (Let us open Bunny's mouth—for tame Bunny has teeth like those of wild Bunny—and see if his front teeth are sharp, long, and strong. What do you see? (Two long, sharp, strong teeth in each jaw.) Here are some of Bunny's teeth (taken from a skull) and here are some knives. Let us see if the front and back part of the teeth are equally hard. (The front is the harder.) As he nibbles the hard bark what will become of the softer back of the tooth? (It will wear off faster than the front part.) What will that do for the tooth? (Sharpen it.) Will not the teeth finally be worn down to the gum? (They would, did they not keep growing out from the gum.) What would happen to Bunny did he not wear off his teeth? (They would keep on growing and become great tusks.) (The teacher might cite examples of deformity caused by one tooth being broken off.) Do you blame Bunny, then, for nibbling something hard?

Look at Bunny's mouth. Do you see anything about it that helps him in nibbling the trees? (The upper lip has a deep cut. How does this help? (The lip is out of his way when nibbling, and so does not get hurt by rubbing against the tree.)

After Bunny nibbles off the food what does he do with it before swallowing it? (Chews it.) With

his sharp front teeth? (No, with chewing teeth such as we have.) Let us see if Bunny has such teeth? (He has.)

Now Bunny has finished his breakfast or supper off the bark of the tree. Has he harmed the tree much? (Killed it if he has gnawed all the way around.) How is that? (The roads through which the sap passes from roots to leaves, and from the leaves back to the roots, are spoiled.) [This presupposes a study of the tree.] And so the fruit grower would like Bunny to stay away from his orchard, and when the weather is warm and there is plenty of clover and vegetables, Bunny is willing to do so.

Has he ever been to your garden? Did you see him? How did you know, then, that he had been there? The parsley, lettuce, beets, etc., told the story. Does he like flowers, too? Yes, and he has good taste—a great liking for carnations and other pinks. Now this tame rabbit eats as does the wild one, so we will ask him to show how the gray rabbit eats, since we cannot catch gray Bunny eating. We will feed him parsley and carrot and apple. Children try many different kinds of food

What have we found Bunny using his front teeth for? (Gnawing.) Now watch him. What does he do with the parsley? (Bites off a mouthful, then chews it.) And with the tender leaves of the beet? (The same.) And what does he do with the apple? (Gnaws off a little at a time.)

Then he uses his front teeth for what? (Gnawing and biting.) And his back teeth for what. (Chewing.)

What do you like about gray Bunny's looks?

For help in study of rabbit, see Dr. Lockwood's "Animal Memoirs," I.

Children picture the rabbit.

THE HORSE.

We have been learning many things about some of our animal friends. What ones? (The dog, the cow, and the sheep.) Can you think of any other animal that does very much for us? (The horse.) How many of you have horses at home? Tell me some of the things your horses do for you. Tell of some of the heavy loads you have seen them draw. Could men draw such loads? How is it, then, that horses can pull so much? They are very strong, much stronger than men. Do they often appear unwilling to do such heavy work? Do they work very long at a time? (Nearly all day, often.) After you have worked a little while you become tired and stop to rest. Do horses ever need to rest? Can they stop whenever they wish? Why not? Do masters think about their horses becoming tired? (Kind masters do.) The children have probably noticed horses with heavy loads being stopped on the road that they might rest. Is there any danger of putting on too heavy loads? Children have no doubt noticed that sometimes horses have more than they can well draw. How

do the horses show that the load is too heavy? (By trying very hard to pull it.) *Must* they draw the too heavy load? (Yes, unless the master is kind enough to take some of it off.) Why does not the horse refuse to draw such a load? His master would whip him and *make* him do it. What do you think of treating horses this way? Sometimes horses refuse to try hard to pull a load. Have you ever seen horses refusing to go? What do we call this? (Balking.) Have you noticed the size of the horses that are kept for heavy work? They are very large and have strong, heavy legs.) What other things do these horses do for us? (Draw plows, harrows, reapers, etc.) What else do horses do for us besides drawing heavy loads? (They draw us in buggies, carts, and sleighs.) Why do you not drive cows? (They go too slowly.) In some places they work cows. Here is a picture of some oxen taking a load of children to a picnic. Where oxen are used, it is usually to draw heavy loads, not to take people out for the pleasure of a ride. When you are out riding do you like to go fast or slowly? Do the horses that people drive fast look just like those they use for heavy work? (No, they have lighter bodies and their legs are more slender.) Why is this better for driving?

Compare movements of the heavy Newfoundland dog with those of the light rat-terrier or greyhound to show that heavy animals are slower in their movements than the lighter ones. Does

the horse seem to enjoy going out for a drive? How does he show that he enjoys it? How do horses know which way you wish them to turn? (If the driver wishes the horse to turn to the right he pulls the right line. If he wishes him to turn to the left he pulls the left line. When he wishes him to stop he pulls both lines and says "whoa.") How can the lines tell the horse where and when to turn? (The lines are fastened to a bit in the horse's mouth.) Of what are bits made? How do they look? (Children show by a drawing.) Afterward, if any child has never seen a bit, the teacher shows one, explaining how and where the lines are fastened. In what part of the mouth is the bit held? [Children observe that the horse has front teeth and back teeth, and that between the two groups of teeth there is quite a long vacant place. Into this the bit goes. Children show place for bit by diagram on the board. The teacher has a bridle in the class.] What is this I have here? (A bridle.) What are these pieces of leather for? (To hold the bit in place.) Notice what is fastened to the sides of the bridle. (Two square or oblong leather pieces.) Why are they there? (To keep the horse from seeing many things. They might become frightened at some of these things.) Without these blinders, as these pieces are called, could the horse see things at either side without turning his head? How is that? His eyes are so placed in his head that he can see

to the front and to the sides also. The eyes are far apart and are large. Would you like to have to look straight ahead all of the time? Can you see things to the right and left without turning your head? Not well. Why not? Do you suppose the horse likes to have his view of the sides of the road cut off? Some masters have their bridles made without blinders. What do you think of that?

But horses with blinders, and horses wholly blind, sometimes become frightened. What could frighten a blind horse? (Sounds of cannon, fire-crackers, barking of dogs, etc.) How does the blind horse know of these? (His ears hear them.) Has the horse good ears? Tell me how you know. On what part of his head does he carry his ears? What shape are they? Did you ever see him move his ears? How? When? Why? Do the horse's ears ever lie down? When? You may draw the horse's head showing where his eyes and ears are. Where shall we draw the ears? (Standing up side by side from the top of his head. Look closely at their shape.)

We all know how to *guide* the horse; let us see how he pulls a buggy or sleigh. Is it in the same way that you pull your hand sleds and express wagons? (No, we pull them with our hands. The horse has no hands.) No, the horse's arms are his fore legs, and it cannot take hold of the buggy with them, but I have seen children draw sleds very much as your horse draws your sleigh or

buggy. How is the horse fastened to the sleigh? [Children explain from observation.] The purpose is to show how the pulling is mostly done by the breast and shoulders. In the same way children sometimes in drawing a loaded hand sled, have double ropes fastened to the two sides of the round in front, which they put over their shoulders so that the weight rests there. Any who have never drawn sleds in this way are shown how. Do horses get tired traveling all day when the load is light? (Yes, if driven fast.) How do they show that they are tired? (Go slowly.) Then what does the driver often do? (Whip them to make them go faster.) And what do the horses do? (Go faster. They have to do as the driver wishes, and if he does not care for his team they will often have a hard time.) How do horses show that they have been driven too rapidly? (They are covered with sweat, even in cold weather, and they breathe fast, the breath coming from their great nostrils in clouds.) What care should they receive at the end of their journey when they have been so overdriven? (They should be wiped dry with a cloth, then covered with a blanket. They should not be given much water to drink at once, although they are thirsty, but should wait until they are cooled off.)

How else are horses used beside to draw heavy loads and take you out riding? (People often ride on their backs.) Did you ever ride horseback?

Did the horse walk when you were on its back? In what other ways do horses sometimes move along? (Sometimes trot, or pace, or gallop.) How do the horses' feet move in trotting? Children observe that the right fore foot and the left hind foot move forward together. How do the horse's feet move in pacing? Children see that the two right feet are raised at the same time, then the two left feet.

How do horses gallop? Children notice that the fore feet are lifted together, then the hind feet.

Can you tell whether a horse is walking, trotting, pacing, or galloping, without seeing it at all? (Yes, sometimes, by hearing the sound of its feet as they come down on the ground.) What is it about the foot that makes this noise? (Its hard hoof or its shoe.) What is this hoof? (The horse's toe-nail.) How is it different from the cow's hoof? (The cow has two on each foot. Its shape is different.) Of what shape is the horse's hoof? Does it go all the way around the toe? Picture its shape on the board. Where is the hoof the broadest? Where narrowest? If this hoof is the horse's nail, on what does a horse stand? (On one toe-nail.) What kind of toe-nails must these be that can hold up the heavy body of the horse and can stand being brought against the hard ground or pavement? (They must be strong and hard.) Should you not think that they would

wear off? Look at some horse's hoofs. (The lower part looks ragged.) Do you ever lose part of your nails? (Yes, mamma cuts the ends off.) Then do they stay short? (No, they grow out again.) So the horse's hoofs or nails wear off and grow out again as your nails do. It is better for the horse to have his nails trimmed, as you have yours, but sometimes they are allowed to grow rough like those we have noticed.

How do horses keep from slipping on ice? (They wear iron or steel shoes usually.) [Teacher has a shoe in the class.] How are these shoes put on to the horse? [Visit a blacksmith shop if possible.] Does it hurt the horse to have the shoes nailed to his hoofs? Does it hurt you to have your finger nails cut? Neither does it hurt the horse to have nails driven into his hoofs. How many nails are put in? How are they driven through the shoes? [Children notice the holes for nails, in the shoe.] What are these three sharp pieces—two at the heel and one at the toe —extending downward? (Calks.) What are they for? (The horse is so heavy that as it comes down with its weight on its shoes, these pieces cut deeply into the ice, keeping the horse from slipping.) When a horse is shod with such sharp shoes, we say he is rough shod. Look at the tracks of horses on the ice. What do you see?

In the summer or during time of good roads, some horses wear smooth shoes, like this—show-

ing one. Feel of it. If, before, we said the horse was rough shod we might now say he is how shod? (Smooth shod.)

What else does a horse use his feet for beside walking, running, etc.? (He strikes with them to knock off flies. He kicks his enemies.) Children give examples. How else does he protect himself? (He bites.)

We have found that horses can be driven in winter without danger of falling. But do they not get very cold without overcoats? (They have a hair coat.) Shall we call the skin an under coat? This is thick and warm. These coats keep the horse warm enough when traveling. What shall be done for horses when standing waiting for us? (They should be covered with blankets.) What protection do they need in cold weather, when not working or traveling? (A good warm stable, with a straw bed to lie on.)

Do the horses wear the same coat winter and summer? (In the spring they shed their old coat and keep only the new one that began to grow out the summer before. So they are not dressed as warm in summer as in winter.) Children relate what they know of the horse shedding his coat. There is other hair on the horse which protects him in summer. What is that? (His tail.) How does he use it? (To brush flies off.) Does it look like the cow's brush? (No, the long hair is at the end of the cow's tail, but all the hairs of the horse's

tail are long. Children show difference by drawings on the board. Where else is the hair long on the horse? (On the neck.) What do we call the long hair there? (A mane.) How would you like the looks of a horse without a mane?

We have found that the horse does a great deal for us. What makes him strong and able to work? (Good food.) What does the horse like to get in the summer time? (Green grass, and he likes to be out in the pasture and get it for himself.) How does he get the grass into his mouth? (By the aid of his thick lips.) And how does he bite it off? Has he or has he not teeth in his upper jaw? Children *observe* that he has. After he has the grass bitten off what does he do? (Chews it.) Does he chew hay and grass as much as the cow does? (More.) Children observe. Does he chew a cud as the cow does? Watch your horses and see. (They do not.) When this question is settled they will see that since the horse does not re-chew his grass or hay as a cud, it is well that he chews it more at first. Notice how his jaws move in chewing. Up and down or sidewise? Have jaws of horse in class, if possible, that the children may see how well adapted their large back teeth are for grinding up the food.

What else do horses eat besides grass and hay? (Straw, fodder, oats, wheat, corn, and carrots.) Observe and compare his manner of eating these with that of the cow. How does the horse eat

salt? How drink water? What other animals drink in the same way? What one drinks differently? Does the horse drink much? How much? How often should he be watered? (Best to have water in the pasture so the horse can get it whenever he wishes.)

How does the horse let us know when he wants to be fed or watered? (He whinnies or neighs.) Tell of some other times when he whinnies. (If his mate is taken from the field or stable he whinnies for it. That is the way, too, the mother calls her little colt. Horses sometimes whinny for their masters, too.)

The teacher should insist on the children making the observations for themselves.

Frequent reproductions by topic should be required. Thus: "Tell how the horses are kept from slipping on the ice." "How are they protected from the cold?"

Make a drawing of the horse. Draw cow, horse, and dog.

THE CHICKEN.

(Type of birds.)

In the story of "The Four Musicians," which musician first saw the light in the robbers' hut? (The rooster.) How did he happen to see it? (He was up in the top of a high tree.) How did he get up so high? (He flew to one of the lower limbs of the tree, and from there to a higher one, and so on.) How do you know? (I have seen chickens

fly up into trees and that is the way they always did.) Why doesn't it fly directly to the top of the tree from the ground? (Its wings are not strong enough to carry its heavy body so far without stopping to rest.) Does a chicken have much flying to do? When does it fly? (To and from its roost.) Where does it roost? Where did the rooster roost after his good supper in the robbers' hut? Have you seen chickens fly at other times than those just spoken of? (Sometimes, when they can not get through a crack, they will fly over a fence.) How? [Children repeat their observations.] They usually fly to the top of the fence, light there, then fly down on the other side. Why do they make so much noise with their wings? (It is such hard work.)

Do you know what is sometimes done to chickens to keep them from flying over fences? (Their wing feathers are clipped on one wing.) How does this hinder them from flying so high? (They cannot balance themselves.) How does a chicken fly? (By beating its wings against the air.) You can raise your heavy body a little way from the ground by pushing down on two posts driven into the ground. A bird has no posts to push against, but it can press against the air. That is always handy, too. [By the use of a light fan, fanning downward and outward rapidly, the children become conscious that there is a resistance of the air.]

We do not wish to go deeply into this subject. Perhaps it would be wise not to touch upon it at all, but usually the interested children bring up the question and force some explanation of *how birds fly*. The motions of the wings made by the chicken in flying—are they slow or rapid? In raising its wing why does not the air above push the bird back? The chicken does not raise its wing straight up, it cuts through the air with the front of the wing, *so*, showing with the fan.

You have seen the wing of a chicken on the dinner table and it looks much smaller than when on the chicken. Why is that? (It has the feathers off.) [If possible, the teacher should have a gentle hen in the class, also the wing of a dressed chicken, and a wing with feathers upon it. Compare in size the two wings.] Is this hen going to fly now? How do you know she is not? (Her wings are not spread.) The teacher extends and contracts gently the wing of the hen a few times. Does that make you think of anything you sometimes see? (A fan.) When does the chicken close its fans? When it does not wish to use them in flying? Why does it not keep them stretched out all of the time? (They would be in its way.) When? Can you show with your arms how the hen closes her wings or arms? What does she do when she wishes to fly? [Children relate their observations.] Show how, starting with your arms in the position of the closed wings. This

will require close observation. Call attention to the position of the thumb or forefinger in the dressed wing.] Do your arms now look like the chicken's spread wing? (No, the skin that holds the two parts of the hen's arm, or wing, together, is wanting in our arm.) What, then, can you do with your arms that the hen cannot do with hers? (Stretch them out straight.) Picture on the board John's arm stretched out. Beside it picture the dressed wing stretched out. What is this wing mostly made of? (Skin and bones.) Can you think of any reason why it may be well that there is no more meat on it? (The meat would make the wing heavy. She would tire holding out a heavy wing in flying.)

But the hen has besides the skin and bones, what? (Feathers.) Do these help or hinder her flying? (She spreads out these feathers and strikes against much more air than the naked wing could press against. She could not rise at all with the naked wing.) Let us look at one of these large wing feathers and see if we think it is the kind the chicken needs for flying. Lift it. (It is so light that I cannot feel its weight.) Does the chicken need light feathers? Why? Is this feather straight? (No, it curves downward a little.) Is this well? The feathers hold the air under better than they would if they were flat. [They will notice the difference in pressure of a concave and a flat

fan.] How many of these long feathers? Does it need so many?

Pull a feather from this wing, Elta. [The feather comes only after hard pulling.] Is it well that they are fastened so tightly? Why? We will look closely at these feathers. This middle part is called the shaft. Each side is called a web. Is the web of the same width on both sides? (Notice how the feathers are arranged on the wing.) The narrow web of one covers the wide web of its neighbor. Only one side needs to be long and the chicken wishes to have as light wings as possible, as we have said before. Can you think of any reason for having the narrow web over the wide one? Examine the wing. Would it do just as well to have the wide web over the narrow?

Notice one little piece of the web. That is called a barb. Separate carefully these barbs. (They cling closely together.) After you have separated them, smooth them down. What do you notice? (They cling as before.) Hold the feather up to the light as you slowly separate these barbs. What do you see? (Each barb has little teeth on both sides. These teeth fit into those of the barb next to it.) Is that well for the chicken? (Yes, if the feathers let the air right through, it would leave nothing to press against and the chicken would not rise.) What do you notice above these long feathers? Of what use are these feathers? Above these, what? Can you think how else the

chicken is helped by having feathers that shut out the air? (Its body is kept warmer.) How are the little chickens helped by such feathers? (The wings cover the little chicks at night and at other times, and so keep them warm.)

Are all the barbs on the hen's feathers hooked together? [Examine one of the small feathers.] On which part of the feather are the barbs hooked together? (On the part that is on the outside of the chicken. The part that is covered is softer—more like down.) How are the small feathers arranged on the hen? They all point backward from the head, and grow one over another like the shingles on a house, only closer together. The barbed part is on the outside.) Is this well for the hen? Why? (It makes a very thick cover, keeping out the cold, and also sheds the rain quite well, the rain running off the end of one feather onto the next, and so on until it drops to the ground.) Have all the feathers barbs? Where do you find feathers without barbs? Notice how a hen stands in the rain. (With her tail drooping, as if to let the rain have a chance to run off by the way of her tail feathers.) In what other way is the chicken helped to keep dry in rainy weather? Have you noticed what a hen sometimes does during a rain? (She oils her feathers so they will shed the rain.) Will oil shed water? How do you know? Have oiled paper in the class. Pour water on it and see what happens. Where does the

chicken get the oil? (From a little sack just above the tail.) [Show on dressed chicken.] Where does the oil come out? How does the hen get it out? (With her bill.) How can she reach away around there with her bill? (Her neck is long and limber, and she can twist it around easily.) How does she get the oil out? (Presses down on the sack with her bill, and it comes out as does the juice when you press on an orange in which you have made a hole.) How does she carry the oil to the feathers? With her bill? How put it on the feathers? (She passes each feather which she wishes to oil between her two mandibles.)

Her bill is the finest comb the hen has. But her hair combing is no queerer than her bath. Did you ever see a hen bathing? No? Did you ever see a hen in an ash pile or in a pile of dust fluttering around? Just what did she do? [Children find out if they cannot tell.] This is her bath. Does she seem to enjoy it? What does she do when she is through her dust bath? Change her clothes? No, but she shakes out the dust and preens her feathers. (Smooths her old dress.) How? Does the hen never change her dress? Have you not seen many feathers lying around the hen house? Did something pull them out? Do they usually come out easily? How does this happen then? (Little by little she is changing her dress. An old feather falls out and a new one grows in to take its place. Sometimes a hen loses the whole

of her tail at one time.) When does this changing of dress happen? (Late in the summer.) Is this a good time? Why? How do the little new feathers look when they first come in? What do we call them? (Pin feathers.) Examine these carefully if they can be found when this is studied. Why does the hen need to change her dress at all? (The feathers wear out and become much mussed.) Is there any order in shedding her coat? [When one wing feather comes out, its mate on the opposite side is said to fall out also. Watch and see if this is so.] Are the dresses of the little chickens like their mother's? (No, they are covered with down.) How is the down different from feathers? Children see. (Down has no shaft and web.) Before going farther the children tell what they have learned about chickens flying, their wings, and the feathers.

Have any of the other animals that we have studied feather coats? What kind of coats did they have? The shepherd dog, cow, and horse have hair coats, the sheep a wool coat.

Where did we find the rooster in our story, roosting at first? Where later? Where do the chickens that you know roost? Why should they leave the ground? (Sometimes the ground is cold and damp. When on a high roost the chickens are not so apt to be disturbed or killed by rats, skunks, dogs, etc.) How do they hold onto the roost? [If no one in the class can tell, the children may be

given time to find out for themselves by watching the chickens at home.] (Its three front toes curve around the roost in front—*this way*—(showing with the fingers) while its hind toe reaches around behind and steadies it.) But when the hen is asleep will she not stop holding on and fall off? Notice a hen as she raises her foot in walking slowly. How do the toes look? They curl up very much as if holding to a perch. When do her toes spread out? (Only when her feet come down on the flat ground. At other times her feet are in a position to hold onto a perch. And the weight of her body only tightens her hold.) When on the perch do the hens stand up all the time or do they sit? Find out. Do they close their eyes? As you do? They have three lids to each eye. What is the color of this third lid? Notice *how* it closes over the eye.

At what time of day do chickens go to their high beds? (About as soon as the sun goes down.) Do we hear from them at all during the night? (The old rooster crows occasionally.) How early in the morning do chickens get up? (In the summer time, as soon as it begins to be light. In the winter, they, like ourselves, hate to get up into the cold, so they stay on their beds sometimes until after sunrise.) Can you think of any other reason why they do not get up, (or get down, rather,) earlier in the winter? They have not so much work to do. There are no bugs, or worms, or vegetables to which they may help themselves.

What do they eat, in the winter time? Where do they get it? Did you ever notice how the hen eats the corn? [The teacher can feed the one she has at school.] What did she do? (Picked up the kernels very fast, with her bill.) What kind of a bill has she? (It is hard.) Is that well? Why? (It is strong.) Why does she need a strong bill? (It is pointed.) Why is this a good thing? The upper mandible is curved. Is it better so? Why? Notice how the forefinger is curved in picking up a pin from the floor. Notice the shape of the lower mandible. What do you think of that? The bill has sharp edges. Is this well? (Yes, the chicken can cut off pieces of leaves, grass, etc., very easily with such sharp knives. She can cut them off as fast as she can swallow them.) What other animals did we find swallowing food very rapidly? (Cow and sheep.) But was this the last we heard of this poorly chewed food? (No, they re-chewed their grass, hay, etc., as a cud.) Have you ever seen chickens chewing a cud? (They do not.)

Let us see if we can find why a chicken does not chew its food. With what do we chew our food? (Teeth.) What kind of teeth has the chicken? Very carefully open the hen's mouth and the children will see that she has no teeth. Then why does the chicken not chew its food? What becomes of the corn that it takes into its mouth? (It swallows it.) How many have ever

watched the dressing of a chicken? Did you see its crop? Feel *right here* on our hen. That is its crop that you feel. The food that it swallows goes first into that. I have here the crop of a chicken. We will open it and see what we find. [There is nothing repulsive about this to the children, as all have seen dressed chickens, and many have watched the process of preparing them for the table.] Now the corn, grass, etc., stay in the crop until they are very well soaked, then they pass on to the gizzard. Do you know the gizzard? It is the chicken's stomach. Here is one. Feel of it. It is very thick and tough. We will open it carefully. [Peel so as to leave the inner sack intact.] What kind of a coat is this outer coat? (Strong and thick.) We will open the inner coat. What do you see? (The food ground fine, and some pebbles.) Take hold of this inner sack. (It is tough and elastic.) Where is the door through which the soaked corn comes into the stomach? When it gets inside of this mill it is tossed back and forth with the stones and becomes very fine, as you see. From this food the chicken's blood, flesh, fat and feathers are made, and its muscles and bones are repaired.

Name other things that the chicken eats in the winter. And in the summer time what? Where do they find the bugs, spiders, etc.? How catch them? [Children watch chickens and see.] Where do the chickens find the worms? (In the ground.)

How get them out? (With their sharp toes.) Did you ever see a chicken scratch for worms or seeds? How did it do the scratching, with one or both feet? *Find out.* Then when it found something good to eat what did it do? (Picked it up quickly with its bill and swallowed it.) What if a mamma with her little chickens finds something good? (She calls her little chickens with some quick clucks and lets them have what she has found. When *they* get over being hungry she feeds herself.) How can she see the little seeds and bugs? (She has bright eyes.) Where are they? Is this well for her? Why? What shape are these eyes? Of the same color in all hens?

We have spoken of the hen's food, but not of her drink. What does she drink? How? (Puts her bill into the water and then raises her head.) Does her bill move when in the water? What is she doing? (Filling it.) Why does she raise it? (To let the water run down her throat.)

How do you think the rooster that belonged to the band traveled? (Walked.) As we said before, chickens fly but little. On what do they walk? (Their toes.) About what other animal that walks on his toes have we talked? (The shepherd dog.) Does the rooster walk as the shepherd dog does? (No, it walks on the toes of *two feet*, the dog on the toes of four feet.) On how many toes does the chicken step. (Examine tracks in snow or mud.) Does the hind toe help any in

walking? Of what use is it? Are the front toes all of the same length? Which is the longest? Why is it well that the chicken has long toes? (If his toes were very short his body would more easily tip over.) Are their long nails in the way when walking? Why not? Look at the base of the front toes. (A little web is there.) Why? What keeps their toes from being hurt by stones, rough dirt, stubble, etc.? (They are covered by tough, hard rings.) This long part from the toes up to the joint is the chicken's heel. Is the heel naked? No, covered by plates of tough, hard skin. Have you ever seen any chickens with feathers on the heel and toes? Notice how tiny are the little chicken's toes? Can they get around well?

Did you ever call the chickens to feed them? Did they hear you? Then what did they do? How can the chickens hear when we call? Have they ears? Did you ever see them? [Very likely the children may never have thought of a chicken's ears.] The teacher calls attention to the ears on the tame hen, or better, the children find them. Why is it well that her ears are so small? Why do the ears need to be thus protected?

It is said that hen's scent is good, as well as her hearing. How can we find out if this is so? Where is this hen's nose. (The children will find its nostrils, quite likely.) Are they protected?

Now look at this hen and tell me what you *like* about her looks. (Her feathers are pretty.) What

is it that you admire about her feathers? What else do you think is pretty about the hen? (She wears a pretty red comb on top of her head.) How do you like the looks of the little chicks? (They are cunning.) How are they dressed? (In fluffy down.) With their round bodies and heads, and tiny wings and bill, and bright little eyes they make a beautiful sight.

Where did these little chicks come from? (From eggs.) How do you know? (Before the chickens are hatched, the mother hen must sit on the eggs three weeks, keeping them warm all the time, or they are kept warm in an incubator.) How does the hen get food and drink? (She leaves the nest just long enough to get food and water.) Would you know a sitting hen were you to meet one? How? When the little chicks are ready to leave the shell who opens their shell door for them? (They do.) How? (Notice the little drill on the bill.) Do you see it on the bills of the older chickens? At what time of the year do these little chicks come into the world? (In warm weather, usually, in spring or summer.) Why not in cold weather? How do they get a living when young? How many little chicks has the mother often to scratch for? Does she complain about her hard work? (No, she likes it.) How does she call her little chicks when she finds a nice worm? Does she talk with them as she walks out? What does she say? And how do the little chicks answer her? (By a happy

little "peep, peep.") But when one gets out of sight of its mother or gets into trouble? (Then it cries a loud, long, lonesome wail, until its mamma hears it and runs to it, or some person comes to help it. It is a good thing a chicken can let us know when it is in trouble.)

What kind of a sound does the mother make when she sees a hawk in the sky or a snake in the grass? What does this sound tell the little chickens to do? (To hide in the grass.) Does the mother hide, too? (No, she is ready to fight for her babies if there is need of it.) How can she fight? (With her bill, wings, and feet.) Did you ever see her fight an enemy? Tell about it. Teacher also relates instances.

How old are the little chickens when the feathers begin to grow? Where do you first notice these new feathers growing? How big are the little roosters when they begin to crow? How well do they crow? Tell how they look when trying to crow.

Review the life of the little chick from the time the hen goes on to the nest to begin her sitting, up to the time when the feathers begin to grow.

How else are eggs used besides for sitting? Children tell of the many uses of eggs. How do we know that a hen has laid an egg? (She cackles.)

Various drawings are made from time to time. The old hen and a little chick are represented side by side, showing the difference in size.

Frequent reproductions are given by the children on topics assigned by the teacher as: "Tell how the mother hen protects her babies." "Tell how the hen cares for her feathers."

THE ROBIN.

(By comparison with the chicken.)

We have been studying about a large bird that sings but little, and whose song is not very sweet. What bird is that? (The chicken.) Now we shall find out all we can about one of our sweeter singers, a much smaller bird, but one that we see almost as often these warm days. What one do you think it is? (The robin.) [Each child should be encouraged to watch one pair of robins all through the season. The study in school will give them an understanding of what they are to look for, and a desire to continue the observations there inaugurated. The study of one pair of birds will be likely to lead to a liking for the work, which at least will add much to the child's enjoyment of nature.] What kind of looking bird is a robin? Can you tell the papa bird, or male, from the mamma bird, or female? (The female appears to be the larger, plumper, of the two, and is lighter in color than the male.) [By a little practice, when out with the teacher, the children will learn to tell the two apart quite readily.]

What have you seen the robin doing? (Singing, eating, building its nest, etc.) Where was it when it sang? How could it hold onto the branch?

[Study of its toes and comparison with those of the chicken.] How did it stand as it sang? What was its song? Has it more than one? [Encourage children to imitate its songs.] What time during the day do robins sing? Find out. Do both the male and female sing? Notice.

What have you seen it eating? Name all of the things that you know robins to eat. (Bugs and other insects, spiders, grubs, worms, berries, early cherries, crumbs.) Where does it find bugs? (On trees, the ground, fences, etc.) How can it tell where they are? (Its large, round eyes are very sharp.) How does it pick them up? (With its sharp, pointed bill.) Have you ever seen it doing this? Tell what it did. [If the children have not noticed much about it, set them at work observing and have them relate their observations in class often.] On what trees have you seen the robin? Have you seen caterpillers or insects on fruit trees or berry bushes? [The children have quite likely noticed "worms' nests" on trees.] What harm do these do to the fruit and bushes? Have you seen wormy apples, cherries, or plums? The insects and grubs on the trees make the fruit wormy. [It might be well to explain how.] Have you ever noticed any other harm they do to trees? Sometimes they eat leaves of trees and bushes. How, then, do you like to have caterpillars, grubs, and insects on the trees? What will help us to get rid of them? Do the robins eat many? [Watch a

robin a half hour.] (They eat and feed their young every day many more insects, etc., than you can count, even though you can count to one hundred.) What do they do with the worms? (Beat them on the ground with their bills sometimes, until they are dead.)

While robins like best of all, insects and grubs, they do eat fruit, as you have said. What fruit do they seem to like best of all? (Early cherries.) Did you ever think that they earn the cherries they eat? How? What would become of our cherries if the robins and other birds were to stay out of the trees all the spring. (The cherries would be so wormy we could not eat them.) Do you think they earn a share of the cherries? How do people treat them when they go among the ripe cherries? What do you think of that treatment? When let alone do the birds seem to enjoy the ripe cherries? What do they say? "Sweet! sweet!" in high tones. *How* do they eat the cherries? How do you know? (The United States Department of Agriculture suggests that the Russian mulberry be planted near the cherry trees. It fruits at the same time as the early cherry and the birds prefer its fruit.)

When getting spiders or bugs from the ground, how do they get around?

Did you ever see them gathering berries? What did they do? [The teacher must be careful that the points--every one--left over for study, are

called up many times in the class. In so far as these questions result in close observations on the part of the children, is the teacher's work a success.]

Much of the food that the robin gathers is not for itself. How do you know? Where are its babies? (In a nest.) Where is the robin's nest built? (Sometimes in an apple tree; it builds in other trees, also.) In what part of the tree? (In the crotch or in the angle formed by two branches.) Can you think of any reason why they may like to build in apple trees? (Some of their food is handy there.) Of what shape is the robin's nest? Of what built? [The teacher should have several robins' nests gathered in the fall, after the robins have flown.] The typical robin's nest is made up of three parts; the outside of weeds, roots, straw, and small sticks, woven together; the middle of mud, held together by some fine material; the inside of grass, with sometimes a few hen feathers and moss. There are many variations from this type as to material, occasionally one being found with no mud wall; and the shape is not always round. Which made the nest? (The mother bird, or both.) What did the male do when the female built alone? (He watched the nest and sang, and sometimes went to meet the female, when returning with straw, etc.) How much did she bring at a time. (A mouthful.) Then her mate watched her closely while she wove the material into the nest.)

[This should not be told the children. We have no right to destroy their pleasure derived from finding these things out for themselves.] How could the mother give the mud this shape? (She sat down on her nest and pressed her breast against it, now here, now there. You could see her tail moving round and round as she molded her nest.) How did she get the coarse material in shape for the outside? (With her bill and claws.) Her claws and toes are her hands.) [Study of these as adapted to grasping and holding if the teacher has a live robin. If not, it is enough to know that she does use her toes for fingers.] How long does it take to build the nest? (Three or four days; sometimes less.) When her nest is all done, what happens? (She lays some eggs.) How many? (One on each day until from two to six are laid.) Are these eggs as large as hen's eggs? (They are about the size of the little candy Easter eggs.) Of what color.? (Bluish green.) Is that a good color for them? Why? Color resembles that of the leaves of the tree, so the eggs are not readily noticed. [Have some candy Easter eggs of the same color and size as the robin's eggs. Children should be discouraged from taking eggs from a bird's nest. During the drawing recitation the children might mold robins' nests from clay, and put a few little clay eggs into the nest.]

Does anything ever disturb these eggs? (Sometimes bluejays, crows, blackbirds, or owls go to the robin's nest and steal all of the eggs.) What if the robins should see one of these birds near the nest? (They would raise a terrible cry, call their neighbors, and flutter about until the bird might be glad to leave.)

Are the robins ever disturbed while on their nests? (Sometimes at night an owl will go to the nest, snatch off the mother with its bill, then eat up the eggs, or even the baby birds.) Sometimes in the daytime a blacksnake will climb the tree, scare off the mother bird, then steal the eggs or baby birds. What do the parents do about this? (They fly all around the snake and try to peck it and drive it away, but it is not afraid of the old birds, and sometimes catches them, too.)

Do you know of anything else that steals robins' eggs? (Sometimes thoughtless or cruel boys take them. They have not the excuse that the owl, crow, and snake have, for boys do not need the eggs at all. The robins cannot hurt the boys—defend their nests against them. The boys know this, so they take the eggs.) What do you think of that?

What does the mother do with the eggs if they are spared to her? (She sits on them.) How long? (About eleven days.) Does she never leave the nest? (Only to get food and bathe. While she is gone, her mate sits on the nest.) Did you ever see

a robin bathing? Did it use ashes or dust as the hen does? (A robin bathes every day in water.) How does it bathe? Where? [Watch and see.]

After the robin has been sitting about eleven days, what happens? How do the young robins look? Like little chickens? (Not at all.) They are naked and blind, and seem to be nearly all mouth. When a little over a week old, for the first time they see their parents, and brothers and sisters. They never know quite how ugly they look at first, for when they open their eyes their feathers have begun to grow.) What becomes of the egg-shells after the birds are out? (The papa robin pushes them out of the nest with his bill, and he now cleans out the nest whenever it needs it.)

How do the baby robins spend their time? (Eating and sleeping.) What do they eat? How get their food? (The papa and mamma feed them.) Do they eat much? (They keep their parents hunting food all the time.) How do the parents give the food to their children?

Since these birds eat so much, they must grow very fast. Does their home grow, too? (No. So the house is soon too small for so many big birds.) What will be done about it? (The birdies will have to leave. When about three weeks old they bid good-by to their home.) How large are they now? How are they dressed? (Very much as their parents are dressed, only their vests are spotted

instead of plain orange.) How will they get out into the world? (They must learn to fly.) Did you ever watch any young robins learning to fly? Tell what they did. How did the parents act? Watch for young robins learning to fly this summer and tell what they do. Do they learn to fly well? Can robins fly any better than hens? Why? Their bodies are light, and their wings spread out wide.

After the young robins have left the nest do they go back at night? (They never go back. But they are not old enough to feed themselves. The papa bird takes all the care of them after they leave the nest. It is hard work for him to get enough food for three or four such big fellows, but little by little they learn to hunt for themselves.)

What is the mamma bird doing while the papa bird cares for the young? (If this was her first brood of the summer, she goes to work immediately to build another nest and lay some more eggs. She usually builds this nest near the first one. Sometimes a mamma robin makes three nests in one summer and raises three families. She has little time for rest, aside from that spent on her nest.)

What enemies have the little birds? (The cat is one of its worst enemies.) How can kitty catch the birds? What other enemies? (Squirrels and owls carry off the helpless little birds.)

We have found out that the robins are great eaters. In the winter time do we see bugs, caterpillars, and fruit? What do the poor robins do for a living then? (They cannot stay here, so they go South where it is warm, so that there is plenty of food.) The mamma bird and the children go South several days before the papa birds go. It may be that the young go so slowly that the papa birds, although starting several days later, get there as soon. Let us ask some one from the South if they all arrive at the same time. When do the robins come back to us? (As soon as the weather begins to get warm in the spring.) Why then? Do they all come together? (No, the males come several days before the females.) Where do the robins stay before they begin to build their nests? (In thick trees or bushes, where they can keep warm.) Have you ever seen robins here when there was snow on the ground? Do you suppose they were hungry? What could you have done to help them? Picture the robins—the male, female, and baby.

For study of robins, see Dr. Lockwood's "Animal Memoir," Part II, and books by John Burroughs, Leander Keyser, Bradford Torrey, and Olive Thorne Miller.

THE RED-HEADED WOODPECKER.

At the beginning of the spring term the children are asked to watch for red-headed woodpeckers and report the first one seen, as last term they notified us of the first appearance of the robin. To

make sure that the children know what bird they are to look for, the teacher asks: "How many know this bird?" "Tell how it looks." (It wears a red cap, a bluish black coat, with white skirts when at rest, and a white vest.) The female dresses like the male only her colors are not so bright, and she is a smaller bird. Show a stuffed specimen or colored picture if possible.

What bird have we been talking about? (The robin-redbreast.) And what other bird have we been looking for? (The red-headed woodpecker.) How many have seen one? What was it doing? (Knocking on tree trunks, running up trees, or flying.) Why were the woodpeckers knocking on the trees? (They were making holes through the bark.) Why? (To get at the grubs or insects under the bark.) How can a woodpecker make this hole? (A stuffed specimen would be of use in studying the bill as adapted to its work; if this can not be had a good picture could be used to advantage for the children can not get close enough to the bird to examine its bill. There is a good picture in Hooker's Child's Book of Nature, part II, and in "Birds" there is an excellent colored picture.) (Its bill is long, straight, pointed.) Does he make much noise knocking? How does it sound? When he has the hole made how does he get the grub? (He thrusts out his long, narrow, pointed tongue. The end of his tongue is hard and has little teeth pointing backward in this way—showing

by diagram on the board. He can run this tongue out far beyond the end of his bill and do it very quickly. When a grub is once pierced by this hook it cannot get away for the barbs hold it on. But sometimes an insect is too small to be pierced in this way; such are caught by a sort of glue that is on the end of the tongue. They get stuck fast in it.) (If there is any danger that the children may not understand the latter statement a child might take a little glue on his finger and notice how all small particles that he touches with his finger cling to it.)

Can you tell now why this bird is called a woodpecker?

Does it harm the trees to be bored into in this way? (They do not often bore into a tree unless they hear a grub or bug under the bark.) What if these grubs were left in the tree? (They might kill it.) Do trees that are very well and strong have insects under the bark? (No.) What kind of trees, then, does a red-headed woodpecker peck? (Only those that need the woodpecker to cure them—to take away the things that injure them.) Did you ever see them peck at the bark of dead trees? Do you think they were there for insects? Strip off the bark from a dead tree and see if you can find insects there.

Upon what does the woodpecker sit while breaking into the grub's house? (It does not sit at all, it stands up.) How can it do this? (Have

stuffed specimen or a good picture in the class to show how the toes hold him. If neither is to be had, put a diagram on the board.) (He has four toes, two in front and two behind. They have strong, sharp curved claws. These claws catch into the wood before and behind and hold him firmly.) Does he use anything but his claws? Children find out for themselves. (He has a long and very stiff tail. The ends of the feathers are pointed, and these are pressed into the wood and prop him up, just as this brace—showing one—holds this board up.) Do they seem afraid of falling when running up a tree? (No, they go with as much ease as you run on the sidewalk.)

Do the red-heads get insects in any other places except under the bark of trees? (They find them on the outside of the bark and on the leaves of trees, on the ground also.) How do you know? Where else do you find insects? (In the air.) Do the red-heads ever catch them while in the air? Watch and see. They catch beetles and wasps while on the wing.

Do they eat anything except grubs and insects? What? (Cherries, berries, apples, and pears.) How do they eat them? Children observe. Leander Keyser says that they sometimes dig out holes in the top of posts, in dead tree trunks, or in stumps, and hide fruit. He saw a red-head press a berry into one of these holes, then suck out its juice.

Sometimes these birds catch a cherry or a berry on the fly, but usually they alight near enough to it to reach it with their bills. Do they swallow a berry whole? Children find out.

Do you know of anything else that they feed upon? (Once in awhile but not often, you will find a red-head boring holes into good trees for the sap.) Have you noticed these holes? How did they look? (They often extend around the tree in a circle.) It is another wookpecker that does *most* of the sucking. They suck the sap out of these little wells. After a while the wells fill up again, when the woodpeckers suck them dry as before. Do you know of any little insects that like sweets? Where might they go for them? (To these wells.) What might happen to them here? The red-heads might make a dinner off of them. (Dr. Lockwood thinks this is one of the purposes of these wells.)

Do you think he is a pretty good bird to have around? Why? (Review.)

What is the only harm we have found them doing thus far? Ought we to welcome them when they come back in the spring? Why? Do they come at the same time as the robin? When did we hear the first robin? When the first red-headed woodpecker? Could you tell that he was here without seeing him? (The male comes more than a week before the female.) (Yes, by his drumming.) How did it sound? "Tap! tap! tap!"

very fast, then "tap! tap!" very loud, with a pause between the two taps. What did he use for his drum? (A dry limb or sometimes a shingle on the house.) What did he use to beat the drum with? (His bill.) Does he never sing? (No, and he is too happy to keep still, so he beats a drum to make music.) Does he have but one drum? (Each woodpecker has a favorite place where he goes to drum. One spring one wakened me very early every morning by drumming on a shingle in the roof just above my head. They drum in other places, too, as they fly around getting their food.) Find out whether they do most of their drumming in the morning or in the afternoon. How early do they begin? When you hear one, run and ask your mamma what time it is. Do they drum very long at a time? Do they drum constantly, or stop to rest a little once in a while? What do they do when resting? The drumming seems to be a call to the mate. See if the children arrive at this conclusion by noticing that the bird acts as if he were listening, and later is sometimes joined by the female. Does he drum at all when his mate is with him? (Yes, and she seems to think him a fine musician.) Is this the only sound you hear a woodpecker make? (He makes a shrill, lively sound, in which there is no music.) You may tell all you know about the music of a red-headed woodpecker. (Review.)

Where do they sleep at the end of their long, busy day? Leave the children to find this out for themselves if they can. Let them watch near a nest if there be one near their home. (They sometimes, early in the season, sleep in holes in trees, but Leander Keyser says that they usually sleep on an upright or oblique perch, clinging with their stout claws, with their heads pillowed in the feathers on their backs.)

After he has called his mate they two go to work building a nest. Where? (In the trunk of a dead tree that is not too soft, or in a limb, a fence post, or a telegraph pole. When made in a limb it is usually on the under side.) How do they make it? They cut out a round, smooth, straight hole right in front of them, with their bills. They make it large enough around so that the bird can go in. When the woodpecker has gone in five inches or so—show distance by a mark on the board—he begins to work downward, making the hole larger and larger as he goes down ten or twenty inches—show by line. If not possible for the children to see a nest, the teacher should give them a clear idea of it by a diagram on the board. You have learned that the mamma robin builds the nest. Which is the harder to make, the robin's nest or the red-headed woodpecker's. (The red-head's.) Will the mamma have help, do you think? (Yes, the papa bird does half of the work.) Can they work together? Why not? (The mamma

bird works just about as long as the time you spend in this class--twenty minutes--then she flies to an upper limb and calls her mate in her shrill voice. When he comes she seems to tell him how much she has done, and they talk over their plans together. Then the papa bird flies to the nest and works about as long as the mamma worked, while she flies away for food and rest. Then the papa bird calls the mamma bird and tells her about his work, etc.) How do they get the chips out of the nest? (Carry them out with their bills.) How is the nest lined? (It is not lined.) The fine wood or sawdust falls to the bottom of the nest, and this forms a soft bed for the eggs.) Is this a good kind of nest for a bird to have? Why do you think so? (It is protected from the storms, and from the birds and animals that trouble the robin's nest.) What ones? But there is one animal that troubled the robin's nest which can easily get into this nest. What is that? (The blacksnake.) Quite often it steals the woodpecker's eggs or birdies

Do the birds go to all this work to make a nest every year, or do they use the same nest year after year? They always make a new nest and they do not use a hole which they find already in a tree. Can you see the eggs in the nest, or the tiny woodpeckers? Why not? How many eggs? (Six.) How do they look? (They are more nearly round than are the robin's eggs and are larger

than her's. They are pure white and very smooth. Can you tell when there are little woodpeckers in the nest if you cannot see them? (If you are near the tree you can hear the babies cry. They are big eaters and nearly all the time they are teasing for food.) Who feeds them? (The mamma and papa.) What do they feed them? (Bugs, moths, grasshoppers, etc.) When they are big enough to fly about how can you tell them from their parents? (The first summer their heads are not red, but instead a very dark gray, and their wings are spotted black and white. The white on their breasts is not pure white, but dirty looking.)

Do these brothers and sisters have good times playing? (Yes, and the father and mother play, too.) Children watch them and tell what games they play. And, if you have a chance, watch one during a shower and see what it does. The teacher should call for their observations and relate her own, throughout the summer term, and again in the fall.

The children should be taught to be very wary in watching birds, try to keep out of their sight as much as possible, and keep quiet.

Picture the red-headed woodpecker.

CABBAGE BUTTERFLY.

Have you seen butterflies in a "cabbage patch?" Of what color? What were they doing there? Watch them closely and see if you can

find out. (They were laying eggs.) Where did they lay the eggs? What was their color? Was the color any protection? How many were there together?

The teacher might well bring a head of cabbage to the class on which are some of these eggs. Keep in a shady, cool place where the leaves will not wilt, and allow the children to look at these eggs every day.

Encourage them also to watch those on one head in their gardens at home. In about ten days from the time the eggs were laid they will hatch out into tiny green caterpillars. Is it well for them that their color is green? Why? What do they do as soon as they come from the egg? (Go to eating the leaves.) Can you see why the mother laid the eggs just where she did?

A few of these caterpillars may be put in a jelly glass and supplied with fresh leaves every day. The top might be covered with paper in which there are holes for the air to pass through, but not large enough to allow the caterpillar to get out. The children will feed them and watch their growth. They grow to their full length, one and one-half inches or less, in about three weeks.

What happens when they are fully grown? (They hang themselves up.) How? Where does the silk come from? (From the mouth.) In the body of the caterpillar are two long bags which

hold a sticky fluid. This fluid flows through a tube which ends in the middle of the lower lip. The fluid hardens as soon as it comes to the air.

Does it hang with its head up, or is it down? Then what happens? It throws off its caterpillar skin. Make a picture of it as it hangs now.

The children note the day when it goes into its chrysalid state and watch for it to come out. They will need to watch about eleven days, and it will be a joyful moment for them if they are so fortunate as to see it leave its home. How does it go to work to get out? It begins to move about, a slit comes on its back, and it puts its head out, then the rest of its body comes out, and the little green house is left empty.

The children now have the whole life of the cabbage butterfly learned from their own observation, and they will never forget it. It helps them to interpret the life of all caterpillars.

They will gather, feed, and watch other caterpillars. Not all of them will change into butterflies. Some will become moths, and by comparison they will find these differences.

(*a*) A butterfly flies in the daytime, a moth by night.

(*b*) A butterfly holds its wings erect when at rest. The wings of a moth lie flat or slant like the roof of a house.

(*c*) A butterfly has knobbed feelers. A moth's feelers are not knobbed.

CATERPILLARS.

The children will enjoy studying caterpillars at home, if they are initiated at school. The best time to study many of them is during the summer vacation.

When a child finds a caterpillar he might pick the plant or twig on which it rests and put both into a box. After reaching home or school, it is well to transfer the caterpillar to a glass cup or jar where its movements may be watched. This may be covered with netting or perforated paper. Once or twice a day fresh leaves of the kind on which it was feeding when found, should be furnished it, and the glass cleaned. The little captive seems quite happy so long as it has plenty of fresh food and a good appetite.

Often we find caterpillars on the walks or in the road; these must be tested with a variety of food until leaves are found which they will eat. The hairy caterpillars which I found this summer contented themselves with the leaves of the smartweed or a closely allied plant. The plantain was, also, accepted by several. But whenever possible to know its choice, the caterpillar has been fed from its own particular kind of plant.

Some of the caterpillars may begin spinning or otherwise changing, the day on which they are captured. When you find one spinning at school, pass the glass to the children for their inspection, taking care not to disturb the little worker.

Some lesson may suffer for this interruption, but the children have a bit of experience all their own, which they would not care to part with, and school is made pleasanter for this little break in the routine. Long after most of the other lessons are forgotten, the children will look back upon these happy moments of discovery in the school room with real pleasure.

It has been my good fortune twice this fall to see a hairy caterpillar divesting itself of its hairs that it might weave them into its coverlet. It seemed to require no effort. Did it pull them out or bite them off? I am not sure. It did not appear to carry them in its mouth. How, then, did it carry them? This question must be solved by further observation.

How deftly it wove those hairs into its cocoon, spreading them very evenly over its surface. How could that clumsy-looking body, with the still clumsier fleshy feet, move over that web with never a trip, or a break of the dainty silk? In what a business-like way the weaving is done, the thread coming from its mouth as needed, and placed in position by movements of its head and front legs. When the top of the cocoon is to be thickened, it, lying within, turns upon its back and weaves away as if this were its natural position. It really never seems awkward when making its house, yet this is the first one it ever built, and it will never have an opportunity to build another.

Several of the caterpillars use leaves as a partial or a complete outside cover. These are woven firmly together and lined with silk.

Once, in a very close little home, in which there seemed not room enough to stir, the caterpillar turned completely around, end for end. It moved with dignity and grace. I cannot tell exactly how, for I did not understand its intentions at first.

One of the caterpillars which I watched snipped off small portions of the leaves in the glass and wove these into its outer cover. They made the cocoon look very pretty, scattered regularly over its surface. Why did it do this? Has a caterpillar an eye for beauty?

I have named but few of the many queer things which we have noticed while the hairy caterpillars made ready for their sleep.

The glasses which held the cocoons were placed in a dry cellar late in the fall, where they were kept until early spring, when they were again watched by the children for the house-breaking.

In the fall work on the caterpillars the children note the changes and give orally the history of each caterpillar so far as they have observed it. They may also write portions of this history. They also make drawings of the caterpillar and its chrysalis, or the cocoon. The chrysalis and caterpillar are moulded in clay and placed side by side on a plaque.

The older children can do more. They can keep a book, which they might name "Life Histories of Caterpillars." They number the glass in which each little prisoner is confined, and write on the first page a few facts about *Caterpillar No. 1*, viz.:

(*a*) Hairy or smooth.

(*b*) Length, color, and any striking characteristic in appearance; number and position of legs.

(*c*) When and where found, and food on which it is fed.

(*d*) Any peculiarities in its actions.

The next page is devoted to *The cocoon or chrysalis of No. 1.*

(*a*) Length and shape of the cocoon and manner in which it was made; also time of making.

Or description of the chrysalis with account of the gradual change and date of its consummation.

The third page is devoted to *The Moth, (or Butterfly) of No. 1.*

(*a*) When did it come out? Description of the method of releasing itself.

(*b*) Description of the moth (or butterfly).

(*c*) From what flowers does it get its nectar? Color of these flowers?

(*d*) Difference in coloring of male and female.

On the fourth page is given a record of *The eggs and growth of No. 1.*

(*a*) Where were the eggs laid? How many in a place? Color? Form? Size?

(*b*) How long did it take the eggs to hatch?

(*c*) How long did it take the caterpillars to mature? How many moultings? What became of the cast-off skin?

It may be some time before page four is filled out, but watchfulness will reward the patient seeker.

Quite likely more than one page may be needed for some of the descriptions.

Many cocoons are found in the fall. What caterpillar made them is a mystery, so our first entry in the book will be on page two, perhaps—the record of the cocoon or chrysalis.

This book may be used season after season, until every caterpillar in one's locality is known through its whole series of changes.

It is a wonder that more of our farmer boys and girls do not make a study of caterpillars and learn to distinguish the harmful from the harmless. Through knowledge of the habits of those injurious to trees, vegetables, etc., the eggs of many might be found and destroyed.

THE COMMON BLUE VIOLET.

At the beginning of the Spring term or at the close of the Winter term the children are asked to look for violets and see who will be first to find one.

As soon as they become plentiful the children are asked to notice carefully what kind of a home

they live in. Is it moist ground or dry? Is it in the shade or in the sun? In the woods or out?

"Did any of you know exactly where to go to look for violets this year? How did you know?" (They grew there last year.) "Did they grow all winter? When the snow was off the ground could you see them? (No, the frost killed the *leaves* in the fall.) Did it kill all of the plant? (No, the root lived through the winter.) Was it protected at all from the cold? (It was covered with soil; above that were dead leaves, and over all, the snow.) Is snow warm? How could it keep the violet warm? (It shut out the cold air and kept in the warmth.) Do you remember an animal about which we have studied, that is sometimes kept warm by a covering of snow? (The rabbit.)

Did you look for violets at all before they came, this year? Were there any promises of violets? (The leaves.) Can you think of any reason why the leaves should come first? (They make a pretty home for the flower. They stand around it like little soldiers, ready to protect it.) But that is not all. The leaves are the plants' kitchens, in which all the food is prepared for the flowers and the whole plant, as well. The little flowers must have something to eat or they could not grow, so the leaves come first and the leaf fairies get the food ready for the flowers. Can you see the fairies at work in the leaves? (No, they work very quietly and orderly, yet they

must be very busy to get food enough ready for all the roots and leaves and flowers.)

Where does the food which is prepared in the leaves come from? (The roots get it from the ground.) Have you ever noticed the roots of the violet? I have a plant here with its roots washed so that you can see them plainly. Which are the working roots? (The very small ones.) What must these roots have through which to take in their food? (Mouths.) Where are its mouths? (All over its tiny roots.) Can you see them? What kind of food can it take through such little mouths? (Water.) If you put a little salt or soda into water what becomes of it? (It dissolves so we cannot see it.) Could the plant take anything but water through its tiny root mouths? (It could take other things if they were dissolved in water.) It does this and we do not know all of the things that it takes in this way.

How does this food reach the leaves? It first passes along to "the large root," then up the stem to the stalks of the leaves, on, through the large veins in the leaves, into the smaller ones, and so on to all parts of the leaf where it is prepared as food and then sent to all parts of the plant to feed it.

What furnishes the heat for cooking? (The sun.) Yes, the leaf fairies cannot get the food ready unless the sun helps, and so when the sun goes down the food stops cooking and the little fairy cooks rest.

You have noticed that when your mother is cooking, steam arises from the kettles or saucepans. Is the same thing true here? You may place several fresh violet leaves under this glass, look at them occasionally and tell us tomorrow what you saw. On the inside of the glass will be moisture. From what did this come? Can you see the windows through which it came? No, they are too small to be seen.

Through these tiny windows air goes into the leaf and mixes with the food from the roots before it is fit for the plant to eat.

When the food is all ready what becomes of it? (Some of it goes to all parts of the leaf, some to the roots and some to the pretty blue blossoms.)

You said that there were no leaves in the winter. When did these leaves come? How could they grow when there were no leaves in which to prepare the food for them? (Last autumn, before Jack Frost killed the working leaves, this "large root," as you call it, packed up enough prepared food to feed the roots and leaves this spring, until they got well started at their work and could feed themselves.

Let us look at this trunk in which the food was packed last autumn. Why do you call it a root? (It looks like one. It grows under ground.) What do we find growing from it here? (Leaves.) (The teacher should have a number of different plants in the class.) From what do the leaves on this

plant grow? (A stem.) On this? (A stem,) etc. What do we call this part from which the leaves and flowers grow? (A stem.) What shall we call *this*, then, from which the violet's leaves and flowers grow? (pointing to the root-stock). (A stem.) Since it grows under the ground what name shall we give it? (An underground stem.)

How did the little leaves look when they started up from this stem to get a peep into the great world, where they were to make ready a home for the flowers? Here are some on this plant which I took up. (The stalk sticks its back up through the ground first as if to make way for the little leaf blade. Then it comes through with the blade bent over so as to lie close to the upper part of the stalk.) Look closely at the little leaves. (They are rolled tightly from both edges toward the mid-rib so as to get through the ground without being torn or broken.) And does it unroll suddenly? Notice the bases of the half-grown leaves.

What shape is the leaf? Draw it on the board. Does the shape of the leaf help it any after it is grown? [Sprinkle some water on a leaf of a growing plant. It is well to have some growing in boxes in the house.] What do you see? (The water gathers in the center of the leaf and runs down the little trough in its stalk.) Is that well or not? (It carries the water directly to the root where it is needed.) What does the water do?

(Dissolves solid food which it finds in the earth, then is taken in by the little roots, goes to the leaf, is mixed with air and moisture coming through the windows, etc.)

And while the roots are working away and the leaves are so busy, what is the little flower doing? (Growing.) How does it look when you first see it above ground? Picture on the board. What changes as it grows older? (The stem lengthens, lifting the bud higher and higher into the air and sunlight. The bud grows fuller and longer. At last the green blanket that covers little Violet is pushed aside, and we see her blue dress. (Notice how her dress was folded while she was wrapped in the blanket.) Did it get wrinkled? Do you think you could fold a dress and pack it so tightly and have it come out without a wrinkle?

What becomes of the green blanket? Can you see it on your flowers? (It still protects Violet. Her dress is very delicate.)

Do all violets wear dresses of the same tint of blue? Some are dark and some are light. Do they ever wear any other color? (Some violets are white, some are yellow, and some are purple.) Is the dress in one piece? What are the pieces called? (Petals.) Are they all of the same size and shape? (The lowest petal is a little larger than the others, and it has a little pocket behind.) Let us see if we can find anything in this pocket. [This can better be shown with a large pansy.]

We will cut the pocket off. Now pinch it. Taste. What is it? (Honey.) We will call it nectar. Can you think of any reason why the nectar should be there? Can you think of anything that would like it? (Bees and other insects.) Have you ever seen any insects about the violets? Watch closely and tell all that the bees or other insects do.

Later the children will very likely have discovered that the bee alights on the lower petal, then thrusts in his "long mouth"—proboscis—and drinks in the nectar. After that what does he do? You have not noticed closely. I wish you to see whether it goes to another violet or to some other flower. The children will discover that the bee that visits the blue violets, will pass by other flowers and choose only blue violets to visit. Do you know why this is? (It may be that it likes the color of the violet best, or it may be that it likes its nectar better than that of the other flowers.)

Notice carefully the path which the proboscis of the bee takes in going to the nectar. (There seems to be a path on purpose for it right through the middle of the lower petal, and there is a hedge along both sides of this road. What is this hedge? (A thick beard of short hairs running down the two petals on each side of the flower.) I will take this fine stalk of grass and let it follow the road which the proboscis of the bee follows. Then I

wish you to look closely at the grass and tell me what you see. (There is pollen on it.) Where did it come from? What is it good for? (To feed the tiny seeds so they will grow.) Let us look closely at the home of these seeds. Where shall we find them? Each child has a flower and finds the pistil. Where are the little seeds? How is the pollen to reach them? (It must fall on the sticky top of the pistil and pass down through that *tube*, to the seeds.) The sticky top is the stigma and the tube is the style.

Look closely at these new flowers which I have given you and see if you can tell how the pollen is to fall on the stigma. (It cannot reach it unless the bee touches it with some pollen as he comes from the flower.) [Show that this can not be, for just beneath the stigma is a shelf. When the bee comes out his head bumps against this shelf and the stigma is pushed up so that he can not touch it.] Must the poor little seeds starve, then? Can you think of any way in which the pollen might reach them? Notice the bee or other insect as it goes into the violet and tell me as soon as you find out whether or not it touches the stigma in going in. They will find that it does, and as it goes *into* the flower it leaves some pollen taken from some other violet, on the stigma, for the lit. tle seeds.

Will you each watch one clump of violets at or near your home, this spring? See if there will be

as many seed pods as there are flowers. Have you ever noticed these seed pods? Here are some which I gathered last summer. Let us see who will be the first to find one on his clump. What must be done to all the seeds before they will grow? (Review.)

If you see a bee visiting a violet, of what do you feel quite sure? Mark that violet by tying a small string around the stalk, using care that you do not pinch it. What will you expect from it?

Look far down among the violet leaves for something that grows up from the underground stem, about which we have not spoken. Tell me about it tomorrow.

The next day the children are questioned in regard to their discoveries. They will tell of queer little three-sided buds, of roundish, hard balls, something that looked like the flowers but had no petals, etc. The teacher should have some of these apetalous flowers in the class room, showing different degrees of development. It will be easy to find other seed pods also.

What are these? Queer little flowers with no petals. Why do they not come up where we can see them? (They have no pretty petals to show.) Have they nectar? (No, they have no pocket in which to carry it.) How did we say the blue violets call the bees? (By their color and their nectar.) Will the bees come to these odd flowers? Why not? But we see that some of these flowers

have borne seeds. How can that be? [If possible have the children see, but if not, tell them that they have no need of the bees, for the stamens of each flower shed its pollen on the stigma of its own flower.]

Here is something still stranger about these queer flowers. (The teacher has a plant in the class with soil on its roots.) Look as I open the soil. (There are some of those queer flowers below the ground, and some have gone to seed here without ever seeing the light.)

When the pod is ripe, what happens? (It divides into three parts and opens.) What will become of the seeds? (From them will grow new plants.) We will plant some in this box and see if they will grow for us. Mamie may care for the box this week.

If the underground roots were all to die, might we still have violets? How?

What two things were we to find out about the flowers? (1. Whether all bear seeds. 2. If not, whether those which we know the bees have visited bear seeds.)

Review the life of the violet, starting this time with the seed.

THE MORNING-GLORY.

Have you planted any flower seeds this spring? What ones? Among others quite likely the morning-glory may be mentioned. Have you any morning-glory seeds? Would you like to bring some to

school to plant that we may have their pretty leaves and blossoms in our windows? [If the children have not the seeds the teacher will furnish them.]

On the following day a number of seeds are placed in a dish where all can see them well. Notice their colors. (Some are very dark—nearly black—while some are a light yellow—nearly white, perhaps.) You may sort them out, putting the dark ones in one dish and the light ones in another.

Notice their shape. What gave them this queer shape? If they have not noticed the seed pod they will be told that we shall find out later. Ask the children to bring some pods in the fall.

The teacher has in the class two wooden starch boxes, or other boxes, filled with rich soil. The girls plant the white seeds in one box and the boys the dark seeds in another box. Each is labeled.

What do you expect from these seeds? (Morning-glory vines.) What care must the seeds have? (They must be kept warm and must have water.) How much water?

Appoint one careful girl to care for the box of light colored seeds, and a thoughtful boy to care for the other box.

Will there be any difference between the colors of the flowers in the two boxes? Let us find out when they blossom. The boxes are now set away. Where shall we set them?

Now each child is supplied with a morning-glory seed and a pin. Would you like to find what is inside this seed? You may take off its outside coat. (We can not, it is fastened on so very tightly.) I will take the seeds and soak them over night in warm water and see if that will loosen their coats. Is it well that its coat can not be easily removed? Why?

On the following day the soaked seeds are taken to the class. Each child is provided with one and with a pin. You may see now if you can remove the seed's coat. Be very careful not to injure what is inside. What do you find? (Underneath the coat is a layer which looks like light-colored jelly.) And what is inside the jelly? (Two tiny white leaves all crumpled up and between the two and protected by them is a little white stem.) Spread out the leaves. Why, do you think, were they so crumpled? (If they had been spread out as they are now they would have taken up much more room. They were packed in as closely as possible. Did you notice any jelly in the first seed you opened? Scratch a little of the coat off these dry seeds. (It is not jelly here, it is a hard substance.) What is this hard lining of the coat which turns into jelly when soaked? What do you expect these little stems and leaves to do? (To grow.) And what must they have to make them grow? (Food.) Where will they get the food? (The roots will gather it for them from the ground.)

Where are the roots of this little plant? (It has none, yet.) What will feed it until its roots grow? (This jelly which is all around it.) Why did not the little plant begin to grow in the winter, in the paper in which we found it? (It can not eat hard food. Its food must be dissolved for it before it can take it.) Then what must happen to the seed before the tiny plant can begin growing? (It must be wet.) You may make a picture in the left hand corner of your drawing paper, of this little plant as it looks when it first comes from the seed, then we shall remember how the morning-glory began life.

At the same time that the children planted their seeds the teacher planted a quantity in a box by themselves.

As soon as the plants in her box begin to break through the ground, a few are taken up and changes noticed by the children. Where is the jelly? (The plant has little roots now and they have gone to work.) Drawings are made at each stage of the plant's development.

As soon as the leaves are above ground they are compared in color, size, and shape with the same when in the seed. Look closely between the two leaves. What do you see? (A little green dot.) We will watch and see what becomes of it. They will find later that this "green dot" changes into a leaf. Only one? Is its shape the same as

that of the two? Draw the two leaves side by side on the board.

But this was not all that the "little dot" contained, for they see a small bud pushing right past the leaf, and what has it? (Another leaf and a bud.) On which side of the stem does this leaf grow? On the side opposite to the other. Later the children find that the leaves all grow out in this way—first one on one side, then one on the other. They admire the beauty of the shape of the leaf and its delicate texture. They notice the veining and illustrate at the board. Why does it have these veins? (They are the troughs through which the sap passes to all parts of the leaf. They also hold the leaf out, giving it its shape, and allowing the sun, air, and moisture to reach all parts of it.) But why are the vines stretching out their arms to us so pleadingly? (They wish us to help them to stand.) What shall we do for them? (Give them strings for support.)

After awhile the children notice something growing in the axils of the leaves. What is it? We will watch it and see. Some of these turn out to be branches, others flower buds.

The flower buds are watched carefully from the time they are big enough to be seen until they open and close and drawings are made of them showing how they look at different stages of their growth. How long do they remain in blossom? Mark certain flowers and find out. (From

morning until afternoon.) Will this same blossom open again to-morrow morning? Look and see. Can you tell by the looks of a closed flower whether it has blossomed or not? How? Picture side by side, a bud that will open in the morning and one that has opened and closed.

What do you notice about the flowers upon the plants raised from light colored seeds? Those raised from the dark colored seeds?

What becomes of the flower that is through blossoming? How long does its pretty dress—the corolla—remain on the vine after it is through blossoming? Watch and see. Why does it fall off? (It is of no more use.) What was its work?

Let us look at this fresh dress. (It is all in one piece, but you can see where five pieces were put together to make it. The seams show.) Let us open it and look at the inside. (The stamens are fastened to the lower part of this dress. There are five of them, one on each piece of its dress.) And do they fall off with the dress? (Yes.) Are they not leaving before their work is done? What is their work? They bear the pollen that makes the seeds grow. Where are the seeds? Did the stamens shed their pollen before falling? Notice the open flower and see if they do. How does the pollen reach the seeds? (It falls on the stigma and passes down the tube to the seeds, or the bees leave pollen which they have gathered from some other morning-glory on the stigma when they go

into the flower for the nectar, which is at its base; or the wind blowing carries the pollen from one flower to another.) Did the sepals fall with the corolla? (No, they stay to protect the seed-pod.)

The children watch the growth of the seed-pod on several flowers which they may select. They see that finally the style dries up, only a small portion of it remaining. Is its work done? What did it have to do? Notice how long a time elapses after the blossom opens before the seeds are ripened. What happens when they are ripe? Three doors open into three little rooms, in each of which dwells snugly two three-sided seeds. These seeds drop out when the plant is disturbed.

Now we have found out how the seeds happen to have such a queer shape—six of them were packed closely in a little round three-roomed house, and what other shape would have packed so well?

See Margaret Morley's "Flowers and their Friends" for additional help.

THE AUSTRIAN PINE.

(A Winter Study.)

Did the Christmas tree surprise you on Christmas eve? What did it bring you that you did not expect? When the presents were all off and the decorations removed, had it any more surprises for you? You did not care for the bare tree, then? This bare Christmas tree has greater surprises for you than the presents gave. It is

full of secrets which few people find out. Would you like to find some of them out, all by yourselves?

But we must become better acquainted with the tree before we expect it to tell us any secrets, and we will visit one that has not been cut down. What kind of a tree was the Christmas tree? Why was an evergreen chosen? What was its name? Do you think all evergreen trees are alike? The children find out by examining the foliage of different evergreen trees that they differ greatly. The other differences will be discovered later.

We will visit the tree with the long, stiff needles. I will introduce you to it. Austrian Pine, these are my little boys and girls who wish to visit you often.

On this first day the children learn to distinguish the Austrian pine from other evergreen trees by its general appearance. They know it by the shade of green of its dress; its straight, pointed trunk; its arms or branches which extend out nearly straight from the trunk,then curve upwards; its number of branches starting out from the same circle and reaching out in different directions; the gradual shortening of the branches from below upward. After learning to recognize the tree readily, the children make drawings, showing its general shape. This is the picture of the naked tree as it looked after it had lost its leaves in the story of "The Unhappy Pine Tree."

Is it pretty? What gives beauty to the tree? Its dress. And this is a wonderful dress. Let us see of what it is made. (Each child has a small twig.) It is made of needles. And the needles are put up in bundles, only two in a bundle. The wrapper which holds them together is around only one end.

Let us look at *one needle.* The children measure it. It is longer than a darning needle and of different shape, being round on the outside and nearly flat on the inside. It is very strong. We can hardly pull it in two. Is it well that the pine tree has such needles? Refer to the story. Not only goats but caterpillars and insects usually pass the leaves of this tree by. Hail, snow, and sleet cannot injure them much. Why not? Refer to the home of the pine tree. This (Normal, Ill.) is not their home.

Pull out one of these pairs of needles. The children find that it is set very deeply and firmly into the twig. Why is this well? The children discover that the needles in a package so fit together as to resemble in shape a darning needle. Where on the twig are they set? Do you like that arrangement? Why? Does the Austrian pine ever lose its leaves, as do the maples and oaks? How do you know? When do they fall? Do they fall singly or in pairs? What color are they when they fall? Do you see any such on the tree now? If so, where? How old are the needles

when they fall? You can not tell now. Austrian Pine thinks you do not know it well enough yet to find out *all* its secrets.

Now tell all the secrets you do know about the package of needles. Make a drawing of them. What secret has the tree failed to tell you?

We have been talking about the Austrian Pine's dress. Does it wear any ornaments? The cones. Where does it wear them? Notice this carefully. Are they all alike? (Have twigs in the class with cones of last summer's growth, and others a year older.) Notice color and size of each set, the number in a cluster (if you are so fortunate as to find two or three together). Notice cones under the trees and compare them with those on the twig. They are like the older cones on the twig. Do you find on the ground any of the little cones? Why not? Their work is not done. The little leaves on the elms and maples did not leave the tree until their work was done, neither will the little cones.

Let us see if we can find out what the work of the cones is. These cones that have seen two summers are chosen. Where on the twig did we find them? Draw the cone when first brought into the room. Draw also the twig with the cone upon it, fixing its place on the twig. The children notice the queer shapes of the doors with their conical little knobs; also how each door is braced in front by two doors at its side and one before it. The doors are very many, and are

closed so tightly that it is with great trouble that we get them open. Will the cone not tell us what she is guarding so carefully? We will not break into her houses. We will lay these cones where we can watch them. They may change their minds about shutting us out. If possible the children should hear and see the doors pop open. This will happen after they have been in the warm room a few hours.

Now that the cone has opened her doors we will go in and see if we can find what secret she was keeping.

The children discover two little fairies behind each door, each with a large wing. How cozily they lie in the little room. They are well worth guarding. Why? Why were they shut in so tightly? What will open the doors of the cones on the trees? Warm weather. When will they open? What will the seed fairies do then? How will the wing help them? The tiny cones are placed also in the warm room and left there for some time? Why do they not open?

Some old cones may be found with their doors open. Inside are no good seeds. Why is that so? The fairies flew away last spring when the warm sun opened the doors. The children now make a drawing of the twig with cones of two sizes. They tell the secrets of the cones. They draw a single door with the two seeds, and one seed by itself, and tell the secret of the seed fairies. A number of

seeds are kept for planting when spring shall come?

What else do we find on the branch besides leaves and cones? Buds. On what part of the twig do you find these buds? Are all of the same shape? The children find that some are large and pointed, others are round and flat, while others are made up of a cluster of little buds? Why this difference? Let us see if we can find out. A pointed bud is first examined. The children notice how the lower scales curve downward. (If kept in a warm room more of the scales will turn down.) They also notice the great number of coverings.

Are they thick or thin? Soft or harsh? How arranged? All of same length? How held together? (The pitch shows itself after being kept in a warm room some time.) The covers being carefully removed by each child from his own bud, they are delighted to find what they think is a cone. But where on the twig did we find the cones? On the *sides*, but this is directly at the end. What does grow at the end of a twig? Leaves on a stem. What then should you expect to find in this bud? We will put this little bare bud, with a covered one, into this bottle of alcohol. It will keep them fresh, and how shall we label it? We will say we do not *know* what this is. But what do you think it ought to be? Another secret which the tree is not willing to tell us until

we know her better. What was the first secret she kept from us? When may we surely know the secret of the bud? Tell the secrets which you know of the pointed buds, and the one which the tree is keeping from you, but which you think you can guess.

Now, let us see if we can find out the secret of the round, flat buds. The children find that the outside covers are much like those of the pointed buds, but inside of a few covers they find from five to ten tiny buds crowded all the way around a small pointed bud. The inside covers are soft and transparent. When uncovered, the children are apt to think they have again found cones. But where do we find these buds? Do you find such clusters of cones on the tree? The children notice the resemblance between the pointed bud in the center here, and the pointed bud we examined before. They tell what they think this bud contains, and what they think may spring from the center bud. The naked, tiny buds are placed in alcohol with a bud as we found it on the tree. What shall we label it.

There is still another kind of bud, a clustered bud, not covered to appear like a single bud as was the preceding. Does it contain a pointed bud? Where on the twig was it found? On what kind of a twig? These buds are also preserved. Are there any other kinds of buds? The bottles of buds are numbered, and the children from now

till spring frequently review their knowledge of these buds, and their suppositions in regard to them.

Now, this branch on which the needles and buds and cones grew may have something to tell us. Notice carefully the curled-back covers of this pointed bud. Do you find anything like this on the twig? Where? How do you suppose those came there? The children are quick to catch the idea that the bud left them when it began to grow. What did it grow into? A little twig. How long? The children usually suggest that that is exactly what this pointed bud will grow into. If so, what must that be in the pointed bud? A little twig packed away in a very small trunk. And what was the green you saw in the bud? The leaves. How long did it take this three or four inches of twig to grow? A year.

The children see that it must have taken many years for the tree to become so large at that rate of growth. Look back and see if you can find where another bud started. How old is that part of the twig? Find another year's growth. Another. Still another. Are there leaves on last year's growth? On the second? On the third? On the fourth? On the fifth? Sometimes they will find the leaves mostly or wholly gone from the five years' growth, and sometimes there are leaves on the six-year old twig. Where did the brown leaves go? How old when they fell? What

did they leave behind to show that they had been here? A queer little three-cornered card, often turned down at the top.

Notice the twigs with the round, flat buds, or the large clustered ones. The children find the year's growth there to measure only from three-fourths of an inch to an inch. Why so much shorter than on twigs with long pointed buds? Its food had to be divided with those little stranger buds that clustered around it, so it could not grow so much.

Did you ever try to break a twig or a branch from an Austrian pine? Was it easily done?

After a snow storm the teacher takes occasion to call the attention of the children to the sad appearance of the tree. Its branches no more reach up toward the sky, but droop to the earth. It seems as if the tree could never hold itself up as it did before the storm. The children make a drawing of it now and compare this picture with the first one drawn. Why does not the heavy snow break off the branches? Show sections of the tree, where branches have grown, that the children may see how well it guards against such accidents.

What secrets have you found out about the twig and branch? You may draw a branch of seven years' growth. If they have observed carefully they will put no needles on the oldest growth, and perhaps none on the sixth or fifth. But here

are side shoots. From what did they come? Notice where they start out. From what buds do they come? Can you tell? Then we must also find this out next spring. Can you tell yet from what the cones will come? We shall have to watch the tree closely next spring, else it will keep this secret from us. Now what are all the secrets which the Austrian pine is keeping from us this winter?

Do you like this tree? What do you like about it? It is a useful tree, too. For what is it used? For lumber. Children name articles made from pine. The birds come to its shelter when they return early in the spring. The winter birds—crows, owls, etc., spend much time in its branches, which shelter them from the cold winds.

As a summing up of many facts discovered in regard to the Austrian pine, and a reminder of their pleasant acquaintance with it, a collection of the following may be mounted on stiff cardboard: A pair of green leaves, a pointed bud, a round flat bud, an open clustered bud; cones of one, two, and three seasons' growth. (The cone of two seasons will need to be varnished to keep it from opening.) A cone scale, two seeds, a bare twig, a twig with leaves, cross and vertical sections of the wood.

THE SCOTCH PINE.

About what evergreen tree have we studied?

Are all evergreen trees alike? The children discover by examination of the foliage, and observation of the general appearance of the trees, that there are many different varieties. Some have two, three, or five needles inclosed at their base in a sheath, some have short needles all around the twig, others have needles along the sides and in front but not on the back of the twig, while others have flat, fan-shaped foliage.

We wish to become better acquainted with the tree that bears these needles—two in a sheath, not more than two and a half or three inches long.

The children visit a number of trees and learn to recognize them by their outline, the color of their branches—a bronze or yellowish brown,—the irregularity of many of the lower branches, and the mode of branching—in whorls.

What does each whorl of branches tell us? That a year has been added to the life of the tree. How old is this tree? We cannot go to the top, but we can count the whorls of branches up some distance on the trunk, then count the number of sections marking a year's growth on a branch.

From what did this tree grow? (A seed.) Did you ever see one of its seeds? Where shall we look for them? In a cone. Where do we find the cones? Do you see any on the trees now? Let the teacher lead the children to some tree where

they can make the discovery that there are cones of two sizes on the tree. Let this be done at once (early in April, before the new growth has started.) The children will need to look closely to discover the small cones of only a year's growth. They are at the *sides* of the *ends* of some twigs. From one to three inches back from the end of the twig are larger cones. These have lived through two summers. Let the children gather several cones of each size and take to the school room. Supply each child with one of the large cones. How many little doors? (The children may try to count them.) Let us see if the cone will let us open some of the doors and look into the rooms. (The children try to raise the scales, but they cannot do it.) Why are these doors fastened so tightly? What precious thing inside is the cone guarding so carefully? We will not force open the doors, but lay these cones back with the others.

After the cones have been in the school room some time—perhaps for two or three days or less —the large cones will begin to pop open. Happy are the children if they see and hear this bursting of prison doors.

The smaller cones dry up without opening.

After the large cones have opened, each child is again provided with a cone. Let us peep into the little rooms. What do you find? Inside of each door (scale) snugly lie two plump seeds, each

with a large, light wing. Children show by drawings how nicely they fit into their close quarters.

They may now examine the door more closely. They notice how one door is braced at the bottom by two others and it in turn helps to brace another door. The queer shapes of the doors, and use of such a shape, and the curious knobs and their position on the door are all items of interest to the children. The doors are rough and harsh on the outside. Is it so on the inside? Any reason for the difference?

What caused these cones to open in the house? The warm atmosphere. Would they never have opened on the tree? Yes, the warm spring sun would have caused them to open their doors. When the sun has opened the cones on the trees what will become of the seeds? There is nothing to hold them in, they must fall out. As each starts away from its home, the fairy-like wing, by the aid of the wind, carries it away. After a while perhaps it will reach the ground, and were it in its own country it might spring up and make a new tree, but our soil and climate do not suit the seeds and they die, usually.

The children, however, may sow their seeds in a box in the school room and watch their development. Why do not the tiny cones open? They are not old enough. The children will find that the warm sun this summer will not open their doors, it will only make the cones grow.

There is quite a marked difference in the appearance of some Scotch pines. While one tree has the whorls of leaves separated by a bare stem for one and one-half or two inches, others have not this peculiarity.

Let the children watch the growth of the buds on these two differing trees. How delighted they will be to find what causes that bare space on the stem, and who will be the first to find the little new cones that come from the new growth.

This is merely a beginning to a most enjoyable study.

THE COMMON CROW.

How do you keep warm this cold weather? How do we protect horses, cows, and sheep from the cold winds, and the snows and sleet storms? What do we do for the chickens, geese, ducks, and turkeys?

But there are some birds for which we do not think of providing shelter, even on the coldest days, or in the most severe storms. What are they? Let us see if we can find how one of these birds—the crow—lives through the winter. Do you all know the crow? How can you tell it from other birds? It is large and has a glossy black coat. Its bill, legs, and toes are also black. Instead of singing or chirping it says, "Caw."

What keeps this queer bird from freezing? Study its feather coat, comparing it with that of the chicken, previously studied. How adapted

for keeping out the cold and snow and shedding the rain. How are the legs and toes protected when roosting?

Where does it make its home in the winter? Usually in evergreen trees. Is this a good place? Why? The thick foliage protects it from the cold winds and it is hidden from the view of those who might wish to shoot it.

Does it need anything beside a good coat and a sheltered home to keep it alive in the winter? It must have food. What does it eat? Let us watch this winter and see if we can find out for ourselves. The teacher should frequently ask for the results of the children's observations and give them her own, then they will think her questions are not idle ones. The children may find that it eats mice, carrion, hens' eggs, corn, acorns, nuts, frozen apples from the boughs of trees, and the fruits of poison ivy, poison sumac, and other sumacs, sand and gravel. They may discover also that it drinks a great deal of water.

Careful observations made by the children will arouse in them a more than transient interest in the object studied. This, the teacher should work for constantly, and feel quite sure that her work amounts to but little if the children are not interested enough to watch, outside of school, the movements of the animals studied.

Let the children tell what they have observed in regard to the manner in which the crow catches

and kills the mice. What does it do with the hens' eggs? Where and how does it get the fruits of ivies and sumacs? Why eat sand and pebbles? Recall what they discovered in the chicken's gizzard. How is the bill fitted for getting this kind of food? It is long, pointed, hard, and strong. Does it find plenty of food? Did you ever hear this expression, "As poor as a crow?" Many times crows have a hard time in the winter to find enough food. They become very poor and sometimes they even starve to death.

Can you get close enough to crows, usually, to tell how fast they eat? Why are they so afraid? Why do men and boys shoot them? Are they any more afraid of a man who carries a gun than of one without? How can crows get a chance to eat if they are watching for men all the time? They have sentinels out watching. These warn the flock of any approach of danger. What kind of warning do they give? How is this warning received by the crows? What follows?

What takes the crow away from danger? Its strong large wings carry it away. Does it fly high? How do you know? Does flying seem to tire it? Study the adaptability of its wings to flight.

Do crows fly singly or in flocks? Children notice. Is this so at all times of the year? We will notice how they go next spring.

Have they no other way of getting around than by flying? They walk on the ground. Have you

ever seen them walk? Were their steps long or short? How did they hold their bodies? Do they ever run? Do they hop? What were they doing on the ground? Children, picture one as you saw it there.

Did you ever see its tracks in the mud or in the snow? How many tracks did each foot leave? Picture on the board. How did it differ from a chicken's tracks?

What is the crow's work in the winter? Is this all it does the whole year through? No; in spring it builds its nest. Did you ever see it building its nest? Have you ever seen a crow's nest?
Why do we so seldom see one? They are built high up in a tree—very often an evergreen tree.

Have a nest in the class if possible. This nest was taken from a tree after all the little crows were grown up. The crows never use the same nest for two seasons, so we knew they would not need their old home any more.

Of what is it built? The outside is made of twigs and sticks, the inner wall of grasses, leaves, and bark from cedar trees or grape vines. Some of their nests are lined with hair.

Early next spring we will begin watching the crows to see if we can find in what trees they build their nests, and how they get the sticks, etc., to the trees.

How do you know sometimes that the crows are about when you cannot see them? They flap their wings noisily and cry "Caw! caw!"

Abbott says that crows have twenty-seven distinct cries, each of which is accompanied by a different act. It would be interesting for teacher and pupils to observe closely and see if they notice any connection between the movements of the crows and their different notes.

THE SCREECH-OWL.

What birds have been with us all winter? Some of these birds are more often heard than seen, which are these? The owls. Why do we see them so seldom? Have you ever heard them? What sound did they make? Some cry, "Hoo! hoo!" others make a sound variously likened to "the coo of a dove with the sweetness left out," "the whining of a puppy," "the grating of machinery," "the wailing of a little child."

We shall talk of the latter. On account of the unpleasant music which they make they have been given a name of which they cannot be very proud. What is it? The screech-owls.

Have you ever seen a screech-owl? What was it doing? What kind of looking bird was it? Perhaps of a grayish color, or it may be of a rusty red color, with lighter and darker markings. It is from eight and a half to ten inches long. The children show this by placing the hands so far

apart. It has a round head, with two bright yellow eyes in front, each surrounded by a disc of short, stiff feathers. Its head is surmounted by what looks to be two pointed ears. The head makes us think of a cat. Its bill is short and curved.

Where were the screech-owls which you saw? Peeping out from the hollow of a tree or among the thick foliage. Very likely you nearly passed an owl without seeing it, for they keep very quiet and do not cry out if they see a person coming. Its color helps the owl to escape notice, being that of the branches of the tree in which it sits, and its bright eyes, which might attract attention, are nearly closed.

Would you like to find out all you can about how the owl makes a living?

At what time of day was it when you heard the screech-owl? Was it talking in its sleep? No, the night is the busy time of day for the screech-owl. About what is it so busy? Getting its dinner and breakfast. These are such hearty meals that it needs no luncheon in the middle of the day.

What do they find to eat? Mice, English sparrows and other small birds, eggs of birds, frogs, small snakes, fish, grasshoppers, crickets, beetles, moths, the cock-chafer so injurious to fruit trees, cut-worms which, like the owl, turn their night into day.

They are very fond of mice. Let us see how they catch and eat them. Where do they find them? In shocks of corn, in their field nests, around barns and corn cribs, running over the snow. How do they catch them? Swoop down upon them and grasp them with their long, sharp claws. Study the very sharp, long, strong, curved claws on the strong, flexible toes, as to their adaptability to catch and hold prey. Notice the reversible outer toe. How does the owl use it? We are very glad that the owl kills the little mouse almost instantly, so it does not suffer.

How does it eat the mouse? Often tosses it up with its bill in such a way that the head comes down into the owl's mouth, then it makes one big gulp, but often a second is needed before the mouse is down tail and all. Are you surprised that it eats the whole mouse? What parts should you think it might better have left out? The hair, teeth, and bones. Examine these little balls found at the foot of a tree in which an owl had a nest. The children find here hair, teeth, bones, feathers, etc. Where could these have come from? The owl, a few hours after eating a mouse or a bird, throws up one of these balls. If a caged owl is a possibility, let the children verify this from their own experience.

Why do not the mice get out of the owl's way? The owl makes almost no noise when flying, on account of the soft feathers which line the wings

and cover the body. Study the wings with reference to their fitness for noiseless flight.

At what time did you say the screech-owl catches the mice? At night. Both like to hunt after dark. How can the owl see the little mouse? It has large, bright eyes. These are in front of its head so that it can fix both upon one object. Study the eye. How large the pupil is! Why? The pupil is a hole through which the light passes into the eye. Liken to a window, This window is very large in the owl's eye and admits much light. Notice the yellow curtain—iris—which surrounds this pupil. Only a little of it shows at night. Let the teacher explain the use of the iris.

Owls often know when a mouse is near even though that mouse be out of sight. How is that? It hears it? Where are its ears? The children will call the tufts of feathers on the top of its head the ears. Let them discover that there are no ears there. They will find large ears, covered by feathers, just outside the disc of feathers surrounding the eye. This is the only bird that has an outer ear. Notice how the feathers are arranged just outside the ear. How does this help its hearing? Why is it well that the ears are covered with feathers?

What else does the owl eat? Small birds. These, too, it kills almost immediately. How does it catch them? Swallow them whole? No. Tears

them in pieces. Do the birds know that the owl is their enemy? How do they treat it? If they find an owl in the day time they make a terrible commotion. All the birds gather together and scream at it, flying as close to it as they dare. When it flies away they follow it and keep calling it hard names.

How does it catch its other food? How much of this food can it get in the winter. Does it go out hunting on the coldest nights? In the warm weather it often stores up enough food to last it a week or more, and mature owls often go a week without any food, not seeming to mind it. Give instances of the storing, showing what they lay in store.

What, besides food, does it need? Water. It is a great drinker. Owls are sometimes caught by cutting holes in the ice. They come here to drink and are captured.

Is the screech-owl's coat well fitted for a bird which must make a living in the winter as well as in the cold, damp nights in warmer weather? Study carefully the plumage of the owl as adapted to its protection from cold and damp. Unlike many other birds, the legs are covered their whole length, and the feathers even run down each toe. What care does it take of this thick, soft, light coat? It bathes very frequently and enjoys its bath greatly.

We have learned how the owl makes a living for itself. Does it never care for others? There must be little owls sometimes. When do you think the little owls come? In warm weather, in May or June. Have you ever seen an owlet? Where was it? Perhaps in a rotten hole in an apple tree? How far from the ground was the hole? Not higher than this room, ten feet. How is the nest made? The owls choose a hole in a tree, they do not make one, as does the woodpecker. This hole is often not lined at all. There is rotten wood in the bottom, and often dry leaves which have been blown into it; but sometimes the mother adds a few feathers from her breast, and sometimes the parents line the nest roughly with dry grass.

What kind of eggs are laid in this nest? Four or more round, white eggs. Which bird sits on the eggs? The female; and during the day the male, too, sits there if the nest is roomy enough; if not, he chooses a hollow tree near by. How long does it take the eggs to hatch? About one month after the first egg is laid the little owls are out of the shell.

How do they look when first hatched? Did you ever see one? If possible, the children should see one before the season is over. It is a sight they will never forget. The owlets are at first covered with a yellowish-white, downy coat. They look like fluffy balls.

How long do they stay in the nest? About a month. Then they scramble out on the branches. They can climb like cats. Did you ever try to catch one? What did it do? Snapped its bill viciously.

How are they cared for all this time while growing up? Both father and mother are kept very busy providing these hearty children with food. They must work early and late. It would be a sad thing for the babies if one of their parents should be killed ere they were old enough to provide for themselves. We hope for their sake that this may never happen. Before cold weather comes, every owlet is grown and able to care for himself.

Frequent reviews should be made by topic, as, "Tell how the eyes fit the screech-owl for work at night," or, "In what respect does the owl resemble the cat?" (Its head looks like the cat's, it hunts at night, it likes mice and birds to eat, it can climb, etc.)

THE WILD ROSE.

The wild rose is in full bloom in June, before our schools are closed, and is a very simple flower for study. The following are some of the points in which the children will be interested:

It presents no loud color, but passes from pure white, which is somewhat rare, to intense pink, through all the intermediate tints. Not unfre-

quently we find in a single flower exquisite markings and shadings. Its fragrance, too, is as delightful as its coloring.

When the sun is shining the mature rose spreads wide its petals, catching every ray which comes its way, but when darkness reigns it closes, and says to the world, "Good night." Does it close, also, before and during a storm? Watch and see. The closed flower is as beautiful as the open one. When you have seen one you have not seen all, for there are many different arrangements of the petals in closing, but in each the adaptation is so perfect that one wonders that any other plan could have answered so well. Do the petals close at night? Why should the rose close at night? If we notice the texture of one of the petals we find its two sides quite unlike. The soft, velvety upper side might easily be marred by the dew, while the coarser under side seems better fitted to cope with it. This suggests what may be one reason for closing. Later we may find a better one.

Any child can find out how long the petals remain after the flower opens by watching carefully the unfolding of certain buds which he has marked, but he must bear in mind that storms of wind or rain often cut the tender lives short.

Although each petal usually performs its part in closing, occasionally we find one, like a willful child, standing off by itself, rolled up to resemble

a bud. Sometimes, too, one little petal will creep out of the bud many hours before the others are ready. It looks too dismal to be enjoying its joke.

If there is room in the school-house yard, wild roses might be planted there. Here the children will discover many interesting facts about their appearance and growth.

About the time that the petals fall, the stamens change their bright color for a dark brown, and later this color gives place to black. Their work is done, although they do not pass out of sight. The only part of the rose now especially noticeable is the green seed cup with the sepals fastened to its rim, and falling back over its sides. We had noticed this cup but little when the petals stood about and above it, but it has been growing quite rapidly all of the time. Why should this cup remain while the petals fall and the stamens fade? There is not much more beauty to it than to a little green apple which it much resembles. We will open one of these cups—a large one. Inside we find a number of shining yellow seeds. They form a circle around the inside of the cup. All are closely packed together. The outer seeds are rounded on the outside. There is no definite number of sides to each seed, they differ considerably in shape, and we find, too, some seeds that seem to be dried up. Why is this?

We will go back a little. The children have noticed that when they touched the stamens, a yellowish powder, the pollen, covered the tip of the finger. The little pollen sacks have burst and the pollen is free. Much of it falls on the little green cushion in the center of the flower. By opening one of the smaller cups it will be seen that this cushion is the feathery top of many small tubes which reach down to the seeds. The pollen touches a little seed and says, "Wake up and grow," and the seed obeys. The ovules that did not develop into seeds failed to receive the message so they did not grow. The petals need to guard the pollen that its seed children may thrive. Does the closing of the rose at night help to do this? Is it well the petals are so delicate on the upper side? Why?

For how long a time the seeds grow before they are ripened can be learned by the children by recording the time of the falling of the petals on a few marked roses.

As the seeds grow the little cup which holds them grows. At last when they are ripened, the cup proclaims it to the world by its changed color, now a bright red. But this is a covered cup. How are the seeds to get out into the world? Has the plant been working so hard for nothing?

"That red cup looks very attractive," says a birdie, and down it pounces upon it, breaking the cup and scattering some of the seeds, while it

eats what are left. So the rose feeds the birds and the birds free the seeds. Nature's children are everywhere helping one another.

A WINTER STUDY OF THE FOX SQUIRREL.

It is supposed that this study will be carried on with classes of children only who are acquainted with this squirrel, and to some extent, with its habits. A live squirrel, if possible, will be brought into the class whenever facts in regard to structure need proof.

The following questions may be asked for the purpose of finding out how much the children already know about the animal: Where have you seen fox squirrels? How could you tell them from other squirrels? Their color was orange (or red) and gray. What have you seen them doing? Did you ever visit at one of their homes? Where was it? How did you reach it? How was it furnished?

We will see if we cannot become better acquainted with this lively little fellow.

Have you seen any this winter? Was it on a very cold or a mild day? At what time of day? What was it doing? Watch closely and see if you can find out. Can you ever tell that a squirrel has been out, even though no one has seen it? How? What kind of tracks does it leave in the snow? Notice them so carefully that you can draw them on the board. How do they differ from the rabbit's tracks that you have been noticing? If you were

to follow these tracks, what might you find? The squirrel's home. We will not disturb him, but sometime when the house is empty we will climb up and peep in and see if he has a comfortable home. The children, quite likely, may find the nest in a hollow of a tree. It is lined with leaves and moss, perhaps. How many rooms? Only one --a bedroom. Does one squirrel live here alone? There is a whole family of them, quite likely-- father, mother, and two or three children. Perhaps you can find out how they pack themselves away in this snug home.

Did the squirrels dig out this hole in the tree? Why do you think they did not? Why should they choose such a place as this? Did you ever see squirrels out house hunting? Did you ever see them fitting up their home? How did they carry the leaves and moss? How many of the family worked? At what time of year was it? Do they have a door to their house? How, then, do they keep out the wind and the snow? Is there a furnace or a stove in this house? How, then, can they keep warm? They wear very warm fur coats. Without a squirrel, the study of this covering can be made from a dried pelt. Is there more than one coat? Notice the inner coat. It is very soft and compact, a dark drab next to the skin, resembling cotton batting. What does this coat do for the squirrel? Notice the outer coat. This coat is coarser and not so compact. Do the hairs stand

straight out from the body, or do they lie down? What is the use of this coat? Which coat gives the color to the animal? Notice these long hairs in which the dark and light alternate. Which color is at the tip of the hairs?

These are not the squirrel's only protection from the cold. What beside? He carries with him a beautiful fur cloak—his tail or brush—which he wraps about him when he lies down to sleep. Call attention to the richness of coloring in this cloak. The upper part in this specimen before me is a beautiful combination of black and orange, the orange tipping every hair—while the under part (which is the upper part most of the time) is a light orange.

We have found that the squirrels are very comfortable even in cold weather. But are a good home and warm clothes all that are necessary to keep them alive? They need food. What do squirrels eat? How can they get these after the fruit and corn are gathered and the nuts which remain on the ground in the woods are covered with snow? They stored up food in a pantry in another hole in a tree, not far from their sleeping room. Did you ever see them gather nuts for the winter? How did they carry them to their pantry? How many worked at this? Did you ever come across their store of nuts? Did you examine it? Had they made a good selection? Were there any

wormy ones among them? How do you think they discover that a nut is not sound?

How do the squirrels spend most of the time in the winter? Why do you think so? When they waken and are hungry, how do they get their meals? Scamper off to the pantry. Do they eat at the pantry, or bring the nuts back to the bedroom? How do they hold the nuts when eating? How get at the meat? What kind of teeth must they have to take off the shell in this way? Are they like the teeth of any other animal that you have studied? Much like the rabbit's. Do they chew their food? With what teeth? (If possible, examine these teeth. The skull of the squirrel would be of much service here.) What is the movement of the jaw? Is it well for the squirrel's teeth that he does not sleep all winter? What would be the harm if he were to do so? His teeth keep growing. He needs to keep them worn off at the tip that they may not become too long.

We know a little about the winter life of this pretty squirrel. Its summer life is even more interesting. Let us find out all that we can about that next term. Let us see how early in the spring it begins its work and play. We will find out, if we can, what its summer work is, and what games it plays.

THE FIRST THREE MONTHS IN THE LIFE OF A GRAY SQUIRREL.

Our school children had the rare opportunity in the spring of '97 of observing three gray squirrels from the time of their birth.

We had had the mother of these babies for about six weeks, when, on Monday morning, March 15, our janitor found in the cage five little squirrels. Two died shortly after birth. The little squirrels were perfectly naked, not a hair on the whole body. The bodies of the two largest were two inches long, tail one and one-fourth inches, and the legs three-fourths of an inch. They were very dark red, with the heads darker than the body. The ears were no larger than radish or flax seeds. Their eyes were as large as sweet peas, but were closed tight. Their toe nails were black, with a white tip, and were well developed. The mother purred to them harshly. The babies mewed—a single mew at a time; their voices sounded like that of kittens. We saw two of them getting their dinner the second morning. Their front feet moved in a happy way while nursing. We made them a nest of cotton in a box when they first came. Their mother tore up much paper and added to this nest.

When they were a week old their bodies had become plumper, and they had begun to bleach out. We took one of the little ones from the cage. It squealed like a little pig, such big voice for such a tiny creature. The mother, Fanny was very

tame. We patted her and handled her considerably when the squirrels were a week old without any disposition on her part to bite.

When a week and a half old the little ones began to squeak like mice whenever things did not go to suit them in their home. Their little ears began to stand out. The mother, when she feared some one was going to hurt one of her babies, planted her front feet firmly on its body.

When three weeks old the lids to the eye had become plainly differentiated. The body had changed in color to a dark gray, and gray hairs began to show. They were thickest on the head. The head looked very large in proportion to the rest of the body. The ears were now standing out stiffly. Ten days previous to this the squirrels had been taken to the home of one of our teachers to spend the vacation. Fanny was frightened at being moved, and when her cage was set down in the new quarters, and the box containing her little ones was put in, she grabbed up one little one at a time and lapped it. She seemed to be examining them to see if any harm had come to them. At the close of the vacation they were three times as large, at least, as at the beginning.

When three and one-half weeks old the little squirrels had become very active. Hair covered all of the body excepting the under part, and the inner side of the legs. These parts were still perfectly bare. The tail had grown to be quite large.

The order in which the hair appeared was this—on head, on body, on outer part of thigh, on outer part of leg. The mother's call sounded like a buzz-saw.

When four and one-half weeks old the eye-lids were much swollen and looked to be about ready to open. The head of the squirrel still seemed out of all proportion to the size of the body. For several days previous to this, rusty hairs had been noticeable on their heads, mixed with the gray, and now a rusty line showed low down on each side of their bodies. While the outside of the mother's ear is white, theirs was gray. Their tails were now becoming very hairy. They still continued to do nothing but sleep, eat, and squirm. They were never quiet. For two days previous to this time Fanny had seemed very uneasy. She jumped out of the nest and called her young, but they made no move to follow her. On this day she had many times taken up one of the babies in her mouth and lapped and handled it, especially the latter. We put much cotton into the cage so they might not suffer were she to take them from the box. When lifting one, she usually grasped it by a leg, or the skin on the back of its body—far back.

When five weeks old the under part of the body and inner part of the leg were thickly covered with white hairs.

When five weeks and one-half old we found each little squirrel with one eye partly open. With the two larger squirrels it was the left eye, with the smaller one it was the right eye. The smallest squirrel was of a much lighter gray than the other two, and had no rusty hairs in its coat.

On the morning following that of the above record we looked with expectancy for wide open eyes, but only the little gray had an eye open, its right eye, as before, but this was hardly as wide open as on the previous day. Fanny, about this time, began to lie flat on her back to suckle her little ones. For several days previous to this she had been burying her food in the nest. On this day she took a piece of cotton from her bed, and with her mouth and front paws gave it a good shaking, then put it back into the nest.

On the day following the above record, one of the large squirrels opened neither eye all day as on the previous day. The other large one had both eyes open, not wide, but about half way. The little one had its right eye open but no farther than on the previous day. The squirrel with both eyes open drew itself up so as to peep over the top of the box. Fanny, seeing it, drew it back into the nest. By this time we were in the habit of handling the little ones, and taking them out of the cage. Neither Fanny nor the little ones objected.

When the little squirrels were six weeks old, for the first time, all three had both eyes open. They did not move about much on this great day, slept as usual, but were more restless. Fanny now began sunning herself, stretching out flat on the bottom of the cage.

Two days later than the above record the little squirrels took up cracked nuts in their paws and nibbled them. The smallest squirrel at this time was the most active. On the evening of this day one of the little squirrels kept getting out of the box. Fanny was displeased. Every time it got out she would run after it and, grasping it by the hind leg, lift it into the box. At one time the little fellow ran around on the floor of the cage, in a very animated manner.

Five days later the little ones had begun to walk and run about the cage a great deal, and on this day, for the first time they climbed up the sides of the wire cage. When walking or running they still seemed unsteady on their feet, and when holding up a nut in the paws, as they did on rare occasions, their hind legs wabbled. On this day and once previously, one little fellow worked at its mother's mouth—seemed to be biting her teeth. We examined its teeth and found them just through. We think it was using its mother's teeth as a baby, when teething, uses an ivory ring. The mother was very patient and seemed to regard the operation as perfectly proper. The

little teeth were very tiny and very white. The little squirrels had very sharp nails. We could hardly get them off our clothing when they had been running over us.

One day after the above record all three little squirrels lay down in the bottom of the cage together to sleep.

When eight weeks old their tails were beautiful and they curled them gracefully over their backs. They had by this time become very nimble. They would take away Fanny's nuts when she was nibbling them. Fanny stored away in the box large quantities of nuts, never putting two in the same spot. She covered them by scratching anything over them that happened to be handy, even though it were one of the little squirrels.

Two days later one squirrel would lie on its back, kick up its legs, and grab another squirrel, when a skirmish would follow. They continued to steal the nuts from Fanny's mouth. They were now beginning to eat nuts, kernels of corn, and clover. One lay down and gnawed a kernel of corn as a dog gnaws a bone.

When nine and a half weeks old the little ones teased Fanny when eating so much that she hung by her toes from the side of the cage near the top, to crack nuts. The tails of the babies were now longer than their bodies and very beautiful. The little ones were becoming hearty eaters, their favorite food being hickory nuts. On this day I

wore a snowball. Fanny came to the side of the cage and nibbled at the snowball. When I took it off and gave to her she ate more than half of it.

One day later than the above Fanny and her babies quarreled. She was tired of having them boss her about, and refused to submit.

When ten and a half weeks old Fanny still washed her babies, lapping them with her tongue. She still suckled them, though a few times she had resisted their demands for food. They now looked to be almost as large as the mother. The smallest one was a downright wicked tease. It made a practice of skipping up behind one of the others and biting it, stealing the food of the others, biting them when they wished to eat, and the like. Finally we had to take the little hector out of the cage and give him a cage to himself.

About a week after we took the little squirrel from the cage one of those remaining in the cage died. We knew no cause for its death. We took the other little squirrel from the mother, as she had been taking its choice morsels of food from it. We kept it out only three days as it grieved greatly for its mother. The evening after we put it back it had a hard spasm. Fearing that the room was too warm and sunny we sent all to the basement in another building. Here they were given much freedom and thrived well. This was near the end of the term. The children had watched closely and noted with the greatest interest all

the changes here recorded, and they loved the little squirrels and Fanny very much. They related to the teacher in their Nature Study class what they had observed. If any difference of opinion existed it was settled by further investigation.

OUR MOUSE, JIM.

The children learn a great deal by watching an animal or plant kept in the school room. The following are some observations made of our mouse, Jim.

Jim was not a handsome mouse. He was gray with the under parts somewhat lighter. Our janitor caught him for us in a trap—one of the kind that preserves the specimen alive and unmutilated. Before he arrived we had made ready for him a cage. It was made of woven wire, and was about a foot square. It had a wooden bottom, which the mouse never saw fit to gnaw through. There was a wire handle at the top, and a wire door in one side, near the bottom. This door was of such a size that the top of a glass fruit jar exactly fitted into it. Its cost was fifty cents. A tinner made it for us.

As often as the cage needed cleaning, Jim was tempted by some dainty, to go into a two-quart jar whose mouth had been put into the door of the cage. Once in there, the top of the jar was put on lightly, and the cage was cleaned. Jim, almost without fail, gave himself a thorough

cleaning while in this jar. Standing on his hind paws he lapped his little pink hands, and then proceeded much as a cat does, to clean very carefully all parts of his body, his hands returning to his mouth frequently for a fresh supply of cleansing fluid.

In the meantime the cage had been washed out thoroughly and dried, and a double piece of paper a foot wide but several inches longer was put into the cage, so that one side folded over, forming a roof for a retiring room. Jim had asked for this room in this way: At first we cut the paper a foot square. Jim would invariably push up one side of the paper and go under it when he wished to sleep or meditate. By lengthening the paper we saved him this trouble. He had not ceased to be wary although he knew us well, for he invariably cut out a little window in this private office of his, and slept with his head in such a position that he could look out of this window should he be disturbed.

How happy he was to get back into his clean cage. He would run up one side, throw his head far back, and turn a somersault landing on his feet at the bottom of the cage. This was his favorite pastime. His movements were so rapid, when he was fairly started that it was impossible to tell how he moved.

The children at school were glad to furnish food to the little fellow for the pleasure of seeing

him eat. His mouth was hid from sight. If a grain of field corn was given him, he picked it up in his front paws, standing on his hind legs, exactly as does a squirrel when eating a nut. He first pulled off with his teeth the thin husk on the outside of the grain, dropped it, and beginning at the crown ate downward toward the heart for some distance, then he turned it and ate toward the heart from the opposite side, until one part dropped. The remaining part he ate from the outside inward, nibbling little bites, or sometimes taking larger bites and chewing them. When the one part was eaten, he scurried around, hunting the other portion, which he ate in the same way. If he had an abundance of corn he would eat the crown out of several kernels, instead of eating an entire one. When a kernel of rice popcorn was given him, instead of beginning at the crown to nibble, (the crown is very hard) he began at the softer base.

We expected him to go into raptures over his first bit of cheese, this being considered a mouse's great luxury, but he disappointed us. He nibbled a little from it occasionally, but in a half-hearted way.

He was very fond of cake. One could almost hear him smack his jaws in satisfaction when he got hold of a piece. He would hold it up in his paws, if not too heavy, and eat it in much the same way that he ate the corn. If the piece were

too large he put his head down to it, using his paws in turning it. His hands seemed as necessary to him, for feeding himself, as do ours. We never saw him eat anything without bringing them into use to hold the food in a good position for nibbling.

We watered Jim in a little glass salt-cellar. He cared for water at least once a day. Sometimes he would drink oftener. When the water was put into the cage he would run to it, put his two front feet on the side of the dish and lap up rapidly from the center. Occasionally we gave him milk. This he would sometimes lap from the center, at other times from the edge of the dish only

His hand was very delicate. There were four slender fingers on a level, and a thumb higher up, as in our own hand. The foot had but four toes, the use of the toes being less varied than that of the fingers.

While we do not doubt that that prominent nose served a good purpose, we were not able to demonstrate, to our satisfaction, that he has the keen scent accorded him by some.

His little black eyes seemed to see in every direction at once, and his thin papery ears caught the slightest sound. His whole attitude was one of alertness. A cat that could surprise one such little fellow must be very quick-witted as well as quick-motioned.

So far as we could discover his tail was a useless appendage—not even ornamental we should say, but Jim seemed very proud of it. He washed it with great care, and laid it out in a graceful curve, when resting. We think he would look quite inartistic, however, without this three-inch measure, and were it covered with hair, forming a beautiful brush like that of the squirrel, probably not a mouse would be making history to-day.

TOPICS FOR THIRD GRADE.

The topics selected for third grade have considerable variety and cannot be arranged in any close scientific sequence. We are careful to select home topics which offer abundant opportunity for close examination. In some cases the observations should be continuous during several weeks. It may be well to observe and collect specimens for some time before regular class work in a topic begins. Outdoor observations and excursions to the campus, neighboring fields and groves, and the collecting of specimens by the children in their still wider range of home experiences, will help to render the work interesting and experimental.

The topics chosen are typical, and simple groups observed in this grade, in connection with the studies in still earlier years, will expand and become more definite in later studies. In this grade we are still absorbed in the study of particular objects in nature with all their concrete detail and interesting discovery. We are collecting much material for later classification and scientific ordering. It is necessary to make constant use of their previous experiences and at the same time

to clarify and enlarge them with new and ample material. Every important topic should be deeply rooted in the child's home environment and should be brought into close relation to his other lessons in geography and story, for such associations are natural and appropriate. The type study in each case is more fully treated than those other plants and animals with which it is compared for purposes of grouping or classification. The formal, superficial description of objects is not our purpose, but such an inquiry into the habits, needs, organs, and surroundings as will bring out the life processes, and aid in the detection of causes and adaptations in nature.

The books and references given in connection with each topic are designed to be of help to teachers. They furnish a good deal of suggestion and knowledge of the facts. But the teacher must not rely upon book knowledge as the chief aid. The knowledge gained from books will help the teacher to become much more acute in hunting out the problems involved in the object of study. If the teacher can only learn to be an investigator and thinker, the problems will spring up in his own mind as fast as he collects knowledge by reading and observation. But nature study requires much thoughtfulness, ingenuity, and a certain amount of originality on the part of the teacher. Some of the most desirable books are too expensive for most teachers to buy.

A few of the less expensive and best books for this and the following grade are given in a special list, with the names of the publishers, as follows:

"A Few Familiar Flowers," by Miss Morely. Ginn & Co.

"Elementary Lessons in Zoology." Needham. American Book Co.

"Outdoor Studies." Needham. American Book Co

"Nature Study." Payne. E. L. Kellogg & Co.

"A First Book in Geology." Shaler. D. C. Heath & Co

"Handbook of Nature Study." Lange. The Macmillan Co.

"The Story of the Solar System." Chambers. D. Appleton & Co.

"How to Study Plants." Wood. American Book Co.

"Botany For Young People." Gray. American Book Co.

"A Reader in Botany," Part I. Newell. Ginn & Co.

"Longmans' Object Lessons." Salmon. Longmans, Green & Co.

"The Plant World." Vincent. D. Appleton & Co.

"School Zoology." Burnet. American Book Co.

"Applied Physiology for Intermediate Grade." Overton. American Book Co.

"How to Keep Well." Blaisdell. Ginn & Co.

"The Story of a Piece of Coal." Martin. D. Appleton & Co.

"Town Geology." Kingsley. The Macmillan Co.

"Coal and Coal Mines." Green. Houghton, Mifflin & Co.

"Trees of the Northern U. S." Apgar. American Book Co.

"Guides for Science Teaching." Numbers I, II. III, VIII. D. C. Heath & Co.

"Our Friends the Birds." Parker. A. Flanagan.

"Nature Study in Elementary Schools." Mrs. L. L. Wilson. The Macmillan Co.

"Familiar Talks on Astronomy," by Wm. H. Parker. A C. McClurg & Co.

"Starland," by Robert S. Ball. Ginn & Co.

"The World of Matter." H. H. Ballard. D. C. Heath & Co.

"The Earth and Its Story." A. Heilprin. Silver, Burdett & Co.

FALL TERM.

THE CORN PLANT.

In the fall (September) study of the full-grown plant, stalk, leaves, ears, tassel, roots, growth during the season.

Study also the broom-corn, sorghum, grasses such as timothy, blue grass; the grains, wheat, rye, barley, oats, rice, and millet.

References. See full treatment below.

"How to Study Plants." Wood. pp. 271-280.

"How Plants Grow." Gray. pp. 20-21.

"Grasses, The Plant World." Vincent. pp. 95-102.

"Lessons in Elementary Science." Salmon. pp. 69-73.

"Nature Study Reader, Harold's Rambles." pp. 51-61. Also "Stories Mother Nature Told Her Children." Andrews. pp. 35-41.

THE SUNFLOWER.

September is a good month for its study. It is found abundantly in the gardens not far from the school house, allowing short excursions to examine its blossoms, seeds, growth of stalk, scatter-

ing of seeds. Compare it in size and growth with the corn plant. Examine also and compare with the sunflower the wild sunflower, the dandelion, the thistle, the asters, the golden rod.

Reference. See full treatment below.
"How to Study Plants." Wood. pp. 143-147.
"How Plants Grow." Gray. pp. 164-166.
See the fuller treatment of this plant given below.
Also "Handbook of Nature Study." Lange. pp. 50-57.
"Plants and Their Children." Dana. pp. 248-255.

THE CATALPA AND HONEY LOCUST.

Visit the trees on the roadside and campus. Examine and compare the pods. Notice also the leaves, trunk, and structure of the bark. The common locust tree also should be examined and compared with the honey locust. Compare the pods and seeds of the locust and catalpa.

Consult, for catalpa:
"Familiar Trees and Their Leaves." pp. 185-187; for the locust, pp. 213-218.
"Apgar's Trees of the Northern United States." pp. 93-95; also pp. 127-128.
"How to Study Plants." Wood. pp. 121-123.

THE GRASSHOPPER OR LOCUST.

The fall, especially September, is a good time to study the grasshopper. The children will readily bring in specimens, putting green leaves and grasses in the can or box with the live specimens. An excursion to the campus to watch them leap and fly, to notice their mouths, feet, legs, and

wings in action should precede. What do they eat? How do they escape their enemies? Watch them in the process of moulting. Do they grow in size? What is the difference between young and old? The story of how the eggs are deposited may be told the children. Tell the story of the Rocky Mountain Locust and its ravages.

Consult "Handbook of Nature Study." Lange. pp. 213-216.

"Elementary Lessons in Zoology." Needham. pp. 48-57.

"Nature Study." Payne. pp. 68-70.

Hyatt & Arms. "Insecta." pp. 108-109.

"Elementary Biology." pp. 34-41. Boyer.

"Insect Life," by Comstock. pp 9-21. This has an excellent study of the locust or short-horned grasshopper.

THE APPLE.

Examination of the fruit. Bring in several kinds of apples. How many parts in the seed pod or core of the apple?

What did the apple grow from? Can you see any traces of the blossom? Get the crab-apple, Siberian crab. Have they the same arrangement of seeds, pods, etc.?

What apples are kept late into the winter and why? Plant some of the seeds and raise the plants. When at the nursery (near the school) in winter notice the process of grafting.

"How to Study Plants." Wood. pp. 107-112.

"Handbook of Nature Study." Lange. pp. 4-8.

"Insect Life." Comstock. pp. 168-172.

"One Hundred Lessons in Nature Study." Payne. pp. 14-15.

"One Hundred Lessons in Nature Study." Payne. pp. 20-22.

"Nature Study in Elementary Schools." Wilson. pp. 241-243.

THE NASTURTIUM.

See Miss Margaret Morley's treatment of "The Nasturtium," in "A Few Familiar Flowers," pp. 107-151. A very full and helpful study for teachers. Children should go out for study of the growing plant and flowers.

"Botany Reader." Newell. Part I, pp. 115-133.

THE SQUIRREL.

The red or gray squirrel may be studied in a cage or at freedom, if tame enough.

"Handbook of Nature Study." Lange. pp. 171-174.

"Animal Life in Sea and on Land." Cooper. pp. 390-394.

"Inmates of My House and Garden." Brightwen. pp. 53-56.

FOODS AND TEETH.

Kinds of foods and what they are made from. Milk, bread, butter, fruits, sweets, cheese, meat, fish, game. How to eat and drink in moderation. Ice water, chewing the food, use and care of the teeth.

See "Applied Physiology." Overton. pp. 26-34.

"How to Keep Well." Blaisdell. pp. 46-55.

"Physiology for Young People." pp. 1-12.

THE SUN AND MOON.

Notice the time of rising and setting of the sun, the length of the day and night, the changes from week to week. The sun as the source of heat. Trace the moon through its changes from new moon to new moon. Think out its movements. The sun's heat at different times of the day and at different seasons. Keep a record of the moon's changes for a month. Explain the reflected light of the moon.

See "Starland." Ball. Chapters I and II.

"Familiar Talks on Astronomy." Parker. Talks II, III, and IV.

"Sunshine." Johnson. Chapters I and II.

COLD AND FROST.

Notice the changes from fall to winter. Use the registrations of the thermometer from day to day. Notice the effect of frost on different vegetables and trees, weeds, etc. Examine the frost itself and its crystals. Report how ice is formed in a pail when set out in the cold. How do dogs, cats, sheep, and other animals prepare for winter? Change of clothing with change of season. Wet clothing, wet stockings, catching cold, etc. The warmth of woolens.

"World of Matter." Ballard. Chapters I, II, and III.

"Nature Study in Elementary Schools." Wilson. pp. 154-156.

WINTER TERM.

THE HOUSE CAT.

A good type of the wild animals of the cat family. Padded feet and claws. Stealthy pursuit of prey. Eyes and nocturnal habits. Teeth and food. Fur and whiskers.

"Handbook of Nature Study." Lange. pp. 97-100.
'Lessons on Elementary Science." Salmon. pp. 54-55. pp. 232-233.

THE WHITE PINE.

How can the white pine be distinguished from other pines, Scotch pine, Austrian pine, etc? Notice the arrangement of the limbs on the trunk, the smooth bark, the cones, and how old they are. Compare the foliage with that of other pines and evergreens. How can you tell the age of the white pine? Notice the rings of wood in a branch or trunk that has been cut. Where does the pine grow? Tell of the northern forests. Examine the white pine wood. Notice the effect of snow and sleet on the white pine in winter. Do the branches break off easily or not and why? Locate the white pines in the neighborhood.

"How to Study Plants." Wood. pp. 214-218.
"Handbook of Nature Study." Lange. pp. 252-261.
"Familiar Trees and Their Leaves." Matthews. pp. 256-272.

RATS AND MICE.

Use live specimens, feeding them and watching their actions, use of feet, teeth, eyes, ears.

If nests can be had bring them in and furnish material for nests.

"Lessons on Elementary Science." pp. 65-66.

"Guides for Science Teaching." No. XI. Hyatt's Mammals.

BATHING.

Keeping the skin clean. Effects upon health. Swimming.

"Applied Physiology." Overton. pp. 104-113.

THE GERANIUM AND BEGONIA.

Care of house plants in winter. Visit a hothouse and notice modes of propagation. Kind of soil, water, temperature, sunlight. Examine the blossoms and watch their development. Let children take care of a few plants. A visit to a hothouse is also helpful. A very full and excellent treatment of the scarlet geranium for teachers is found in Margaret Morley's "A Few Familiar Flowers," pp. 181-215.

"Handbook of Nature Study." Lange. pp. 85-89.

THE ENGLISH SPARROW.

Notice its flight, noises, habits, food, treatment of other birds. Where is it chiefly found? Where are its nests?

"Handbook of Nature Study." Lange. pp. 73-76.

'Elementary Lessons in Zoology." Needham. pp. 211-237.

THE NORTH STAR AND BIG DIPPER AND PLANETS.

Notice the movement of the dipper. Compare it with movements of the sun, and moon, and stars. Observe the planets.

"Nature Study for Elementary Grades." Wilson. pp. 103-105.

"The Story of the Solar System." Chambers. pp. 57-143.

Review their knowledge of the sun and moon from observation and previous study. Locate also any of the familiar constellations, as Orion.

THE ORANGE, LEMON, AND BANANA.

Examine the fruits. Where do they grow? Why not found here? Where can we find the plants near home? In hot-houses. Describe the home climate and surroundings of each.

"Nature Study." Payne. p. 15.

The Banana.—See "The Plant World." Vincent. pp. 74-76.

"Lessons on Elementary Science." Salmon. pp. 77-78.

THE PIGEON.

Pigeons may be kept in a large cage, or even in a basement or pigeon house near the school. Watch their flight. Feed them. If possible notice how they care for the young. Observe their perching, feet, eyes, feathers, and wings, noise in flight, cooing. Compare them later with the turtle dove. Tell of the carrier pigeon. Describe the flocks of wild pigeons. How are the tame

pigeons best housed and fed? Of what use are they?

"Living Creatures in Water, Land, and Air" Comstock. pp. 185-187.

"Animal Life in Sea and on Land." Cooper. pp. 291-4.

"Bird Life." Chapman. pp. 112-114.

"Elementary Biology." Boyer. pp. 98-107.

"Inmates of My House and Garden." Brightwen. pp. 93-101.

LEAD AS A METAL.

Bending, pounding, hammering of lead. Lead pipes. Melt lead and mold into bullets. Where does lead come from? What is it used for? Solder. Compare its weight with wood, water, and other things.

"Lessons on Elementary Science." Salmon. pp. 86-88.

"The Earth and Its Story." Heilprin. pp. 212-213.

SPRING TERM.

PLANTING OF SEEDS TO WATCH GERMINATION.

First in the school house in boxes and later in the school garden. Beans, corn, peas, bulbs, radishes, potato, apple seeds, cherry, plum. Later in the season transplant the violets, spring beauties, blood root, and other wild plants, from wood and meadow to the school garden. Transplant the house plants to the garden. Plant, also, the garden flowers, sweet pea, nasturtium, morning

glories, tulips, poppies, pansies, touch-me-nots, petunias, and watch the growth.

"Plants and Their Children." pp. 9-69. Also pp. 80-89.
"Guides for Science Teaching."
"Concerning a Few Common Plants." Goodale.
"Nature Study in Elementary Schools." Wilson. pp. 133-143.

PLANTAIN, DOCK, WILD PARSNIP, AND DANDELION.

Study of the roots of the earliest spring plants and weeds, especially the perennials. Notice their length and food store.

"How to Study Plants." Wood. pp. 143-7.
"Handbook of Nature Study." Lange. Chapter vi., pp. 58-69.

Contrast the long sturdy roots of the perennials with the roots of plants raised from seeds early in the spring.

See the treatment of spring plants below.

THE SEEDLINGS OF COMMON TREES.

The seedlings of one, two, and three years will be found in early spring.

The first year seedlings still attached to the winged seed may be found in abundance. Watch the seedlings till they can be determined as maples, boxelders, elms, wild cherry, ash, tulip, etc.

How are trees planted in the forest? What trees in our neighborhood are raised in the nur-

series? What trees grow wild and scatter their own seed?

References.

"Guides for Science Teaching," No. II, Concerning a few Common Plants. Goodale. pp. 11-19.

"Plants and Their Children." pp. 85-94.

Compare with germinating seeds and with the roots of plantain, dandelion and wild parsnip.

THE RETURN OF THE SPRING BIRDS.

Make a bird calendar.

Let each child make a regular note of birds seen first by him. Robin, blue-bird, black-birds. Or even earlier than these winter birds, as wrens, brown creepers, shrikes, hawks, and owls. Later, snipes, doves, meadow-lark, etc. The main purpose is to be on the watch and to become familiar with the more common of our native birds.

See "Bird Life." Chapman. pp. 48-61.

UNDERGROUND STEMS.

Raspberry, blackberry, milk weed. Dig up the roots so as to show the under-ground stems. Compare the different under-ground stems among themselves and with the running stem of the strawberry.

Later in the season study the radish, beet, onion, and compare with the wild roots of dandelion, etc.

The garden vegetables can be easily obtained for class-room use. They may also be seen growing in the school garden and in neighboring gardens.

THE APPLE TREE IN SPRING.

Buds and blossoms. Watch the first development of the little apples. Do insects visit the blossoms? Notice the colors and perfume. Compare the apple blossoms with the roses. Notice both wild and cultivated roses and compare.

"Plants and their Children." Dana. pp. 9-30.
"How to Study Plants." Wood. pp. 107-112.
"Handbook of Nature Study." Lange. pp. 4-8.
"Insect Life." Comstock. pp. 168-172.
"One Hundred Lessons in Nature Study." Payne. pp 14-15 and 20-22.

THE GRAPEVINE.

Budding and blossoming. The tendrils and climbing of vines. Early buds and blossoms. Forming of the young fruit. How the vines are propagated. Compare it with the climbing vines. Will it grow from the seeds? Notice leaves, stem, bark, and compare with trees. Bring in specimens of wild grapevine.

THE MOLE.

Its work in yards. Its peculiar home, food, and organs. Study a live specimen if possible. Let him bury himself in the loose dirt in a pail.

Feed him worms, grubs, etc. Notice his fore legs, teeth, eyes, etc.

"Curious Homes and Their Tenants." Beard. pp. 21-27.

See description below.

THE MAPLES AND THE BIRCHES.

The growth of the buds, leaves, and fruit through the spring season.

"Familiar Trees and Their Leaves." Matthews. pp. 81-98.

"How to Study Plants." Wood. pp. 188-192.

"Familiar Trees and Their Leaves." Matthews. pp. 192-208.

"Nature Study in Elementary Schools." Wilson. pp. 199-229.

Handbook of Nature Study." Lange. pp. 136-153.

"Insect Life." Comstock. pp. 186-220.

The sugar maple offers a good specimen upon which to study the sap—its character, circulation, functions, etc., as explained in the botanies.

See Gray's "How Plants Grow," chapter III, pp. 85-90, and other botanies.

THE POTATO PLANT.

Seed potatoes. Growth of vine during the spring months. The blossom, little potatoes. The underground stems.

"Handbook of Nature Study." Lange. pp. 187-191.

See the full treatment below.

THE POTATO BEETLE.

Notice them feeding upon the leaves, all sizes, from the egg to maturity. Observe changes in

growth and compare with other insects already studied. Tell the story of the potato beetle.

See "Handbook of Nature Study. Lange. pp. 212-213.

PLANT-FOODS AND THEIR USES.

Starch, sugar.

Corn, potato, wheat, celery.

Tea and coffee.

Water as a food.

Effect of cooking upon some foods.

References:

"How to Keep Well." Blaisdell. pp. 46-55.
"Applied Physiology." Overton. pp. 27-34.

CORN PLANT.

The corn plant is one which is most familiar and yet its points of interest are almost unknown to the children.

Where do we find corn growing in the neighborhood of the school? Before going to see it, (or before bringing a full stalk with the ear into the class), such questions as these may be asked:

Can you draw from memory a correct picture of the full-grown corn plant? How do the leaves or blades stand out on the stalk? Where are they fastened and how? Are the leaves opposite or otherwise? Where is the ear of corn attached and how? How many feet tall is a full grown stalk of field corn? What have you noticed as to the roots and where they grow out? Describe the tassel.

Now bring in the full stalk, leaves, corn, and all, or visit the corn as it stands in the field. Answer the questions definitely that we have previ ously asked, *e. g.* The leaves grow alternately, first on one side, then on the opposite, above, etc. The lower part of the leaf is a sheath encircling the stalk and fastened at the joint. The ear grows up between the stalk and the sheath or lower part of the leaf. The stem of the ear of corn is thus in the axil of the leaf. The roots also spring out from the joints, as do the leaves, and from two or three of the joints. By measuring with a yard stick we find that the whole plant is eight and a half feet tall. The tassel growing at the top branches out in several parts and has a dust or pollen in little sacks.

A second set of questions as follows may lead to a closer examination of the parts: Where the large ear lies between the leaf and stalk what is noticeable in the shape of the stalk? A large groove, or hollow place. Is this the only ear on the stalk? Examine the sheath just below on the other side of the stalk, and by unwrapping and loosening it a second smaller ear, (often a very small one only two or three inches long), is found snugly wrapped in the axil of the leaf. Has this little ear rows of grain, silk, and leaf-covering? Now go to the next lower joint and unwrap the sheath. A still smaller ear and its wrappings are found. What is observed as to the groove in each

case? It is smaller. Examine all the joints and see if an ear or rudiment of one is found under the sheath at each joint. Now what do we find as to the size of the ears and grooves in which they lie as we go downwards? How many ears are thus found on a single stalk? Where is the largest? How many ears of corn on a single stalk are found to be valuable? Are any ears found on the stalk above the large ear? Any grooves?

Now break off a large ear with its husks and stem. Strip off one husk at a time from the ear and notice the stem. A series of joints is found on this stem. What does this remind us of? How many joints are found on this short stem to which the ear is attached? As many as there are separate husks? How many husks are there? About as many as there are leaves on a whole stalk of corn. Are the husks arranged on alternate sides of the stem?

Go into a corn field when the pollen from the tassel is being scattered. Examine the silks also and see the condition of the ear of corn. Explain how the pollen falls upon these delicate silks and causes the grains of corn to grow.

Notice in the corn field how the pollen is scattered over everything. Examine the tassels more closely. How many large ears are found (in different stalks) on a single stem? Are grains or nubbins ever noticed growing on the tassel? This will be of interest in comparison with other plants later.

Let the children try to pull up a corn stalk as it stands in the ground. They will not have sufficient strength. Let them bend and twist it to see how strong its hold, by means of the roots, is. To how many joints are the roots attached.

Cut through the stalk and examine the fibres and pith. What gives strength to the stalk? Notice how thick and firm the fibres are in the hard rim of the stalk. Of what value and use are the joints? Show the marked difference between a cornstalk and the woody fibre of a tree or bush. How long is the corn plant in growing? Does it live longer than one season? Does this large plant, perhaps twelve or more feet tall, come from a single grain of corn in a single season? How many grains of corn does this stalk produce? What sort of soil does the corn grow best in? Recall your experiments in the spring in watching the germination of seeds in boxes, and in the school garden. What becomes of the seed corn that is planted in the ground? Call to mind the different kinds of corn, as field corn, pop corn, sugar corn. What are the differences in size and appearance of different sorts?

Did you observe whether the corn plant has any enemies, as bugs or worms or grubs. In the ends of the young ears we often found a grub which was nested there and eating the grains. How did it come to be there? Have you known of cornfields being damaged by insects? When does

corn grow most rapidly and why? What is the effect of very dry or very wet weather? What is corn mostly useful for? (A brief account of its use for food for animals and man.)

The class should make quick sketches of the corn plant on the blackboard, not so much for the drawing exercise as for purposes of expression and clearer grasp of ideas and facts. The regular drawing lesson of the class might also take up the corn plant as a careful drawing lesson.

If it is convenient, bring into the class a full-sized specimen of the broomcorn plant. Examine the plants closely and compare them step by step with the corn plant. In many points they will be found strikingly similar, but in the production of seed a strong difference is noted. The same sort of study and comparison with the sorghum plant may be found practicable.

The grasses may also be collected, especially the more common, as timothy grass, blue grass, fox tail, etc. Oats, wheat, and rye will also offer interesting facts of structure and comparison. Reeds and wild rice or tall slough grass give children still further opportunity to observe the jointed stems of which the corn is a good type.

The fall (September) is the best time of the school year for the study of the corn as the plants are then full grown though still green and developing. In the springtime, however, the germina-

tion of corn and other seeds should have been studied previously.

It may be well also to call attention to the corn plant as a peculiarly American plant, used by the Indians, and known to the children, perhaps, in the story of Hiawatha. Later on the children will find that it has played a very important role, not only among the Indians, but among the pioneers of most of the states.

It is well to have two or three full specimens of the object studied in the class and to encourage the children in observing the corn and other plants in the fields, to collect and bring in specimens, to ask questions.

THE SUNFLOWER.

Visit a full-sized sunflower in the garden. Measure the height, size, and number of the blossoms. Examine the sunflower. What is the difference between the flowers which have gone to seed and those which are in full blossom? Examine the seeds. What is the number of seeds found in one head? Quarter a head and count. Then estimate the number of seeds in the blossom. This plant has forty heads or sunflower blossoms containing altogether about 1,200 seeds. If these were all planted in the field the next season how many sunflowers could be raised? How do the heads of the sunflower hang? As the seeds ripen where do they fall? Examine the ground and see

if any seeds can be found. How long has this sunflower been growing upon this spot? Does it grow from year to year or does it spring up from the seed in the early spring time? How many months has this plant been growing? Do you think that this large plant, eight or ten feet high, has grown in a single season? How large is the stalk at the bottom? Is it well rooted in the ground? Can you mention any other plants that grow to the size of the sunflower in a single season? Examine more closely the fresh blossoms of the sunflower. Does it consist of a separate flower for each seed? How many flowers, therefore, are found upon a single head? Notice the difference between the seeds on the edges of the head and in the center. What other plants have you noticed producing many seeds in a single head? As for example, the dandelion, thistle, aster? Where have you noticed sunflowers springing up in the early springtime? Are they planted like corn and the grains, or do they spring up without planting like weeds? Notice also, as the season advances and as winter comes on, whether the sunflower is killed by the frosts and what becomes of the seeds, whether they remain on the heads or are scattered on the ground. If these seeds lie in the ground in the winter time will they be killed by the frosts? Of what use are these seeds? Taste them and see if they are good to eat. Do you know any animals or birds that

use them for food? Feed some of them to the chickens, and pigeons, and turkeys, and ducks. Possibly squirrels would eat them. Cut through the stalk and examine the inner parts of the stalk. Can you notice how the sunflower stalk grows? How does it differ from the trees and woody shrubs? Save up some of the sunflower seeds and plant them in boxes and see if they will grow. Examine a number of sunflower plants and see what number of blossoms is upon different ones, size of blossoms and number of seeds. Where does the sunflower grow largest and best? Examine some of the wild flowers which resemble the sunflower, and see if they are similar and in what points they resemble the sunflower. It will be well, also, for the children to draw the full sunflower plant on the blackboard or on paper representing the branches and drooping heads. Why do the heads droop so much in the latter part of the season?

THE COMMON POTATO.

Secure a potato plant in June, about the time when it flowers out and when the little potatoes are setting. Dig up the plant with roots and young potatoes and present it in the school as a complete specimen. Before presenting the plant to the children it may be well to ask them to describe it from memory and then later bring in the plant with its blossoms, stem, and roots for more

accurate examination. When were the potatoes planted in the ground? Were they raised from the seed or from something else? Describe the planting. Describe, also, the growth of the young plants until they blossom out. In examining roots and young potatoes notice whether they are alike, whether the stems upon which the young potatoes grow are roots. Take off all the dirt and examine the stems very closely and note carefully the difference between the roots and the underground stem. Will these little potatoes grow in the ground if they are separated from the root? Where does the little potato get its food by which it grows larger? What is the business of the stem and leaves of the potato vine during the summer time? Where does the plant obtain food with which it supplies the growing potatoes? What sort of soil is best for their growth? What care needs to be taken of the plant? What if weeds and grass grow up in the potato hill? Examine more closely the stem of the potato vine and leaves. Notice shape and color. As soon as the potatoes grow up to full size what becomes of the vine? It may be said that the potato plant, including roots, stem, and leaves, spends the whole summer in collecting food and storing it away in the potatoes, and when this work is done the vine dies and the potatoes remain in the earth. If these potatoes are left in the ground during the winter, will they be destroyed or will they send

up new vines in the spring? Examine the potato blossom more closely and see if it has the same parts as other blossoms—sepals, petals, pistil, stamens. Do any of the blossoms develop into seeds so that they may be planted in the spring and new potatoes raised from them? Examine the large potato and describe the eyes and tell what they are for.

Do you know of any other plants that produce fruit like the potato growing under ground? Do you find also that they have eyes from which new plants grow? What kind of food do the potatoes contain that makes them valuable to man? Examine the sweet potato and compare it somewhat closely with the common potato.

Does the potato vine have any enemies that destroy it or prevent its growth? Call to mind the potato bugs and how they destroy the plants. Give a short account of the history of the potato plant. How far north will it grow?

THE HOUSE CAT.

Why is it that the house cat can see in the night or in dark places? What have you noticed as peculiar in the eyes of the cat? Is there any difference in the cat's eyes at noon time or in bright weather and in the dark or dark places? Examine the cat's eyes at the window where there is plenty of light and after she has been in a dark place, in the closet, for awhile. What difference

is noted? Is it possible to explain from this why a cat can see better at night than we can? Can the cat see in a place where there is no light, where it is perfectly dark? Why does the cat remain so quiet and sleep so much in the day time? Why are they so active and so wide awake at night?

If a cat is pursued by a dog how does she escape? How is she able to climb so quickly up a tree? Examine her feet and claws. Why can she climb so easily? Notice the cat and her feet. What advantage have they? What difference between the claws on the feet of a dog and those of the cat? What kind of prey does the cat seek for? Explain how the claws and the pads on her feet are helpful to her in catching her prey. How does the cat sharpen her claws? Of what advantage are the whiskers to the cat as she moves about? Do they help her in any way, and how? Why has she such soft fur and of what advantage is it? As the cat moves rapidly does she run or leap, and why? As she tries to get away from the dog does she run like the dog or does she spring? Examine her muscles and her bones and see if you can tell why she springs rather than runs. If a cat were wild in the woods where would she live and make her home? And what advantage would she have for catching her prey? How does the cat watch and catch her prey and what sort of animals does she watch for? Examine her teeth. What sort

of teeth has she and of what advantage are they? If the cat were as large as a Newfoundland dog would it be safe to have her about? Have you seen cats catching birds? If you have a pet bird in the house is it safe to keep a cat? What effect will the cats have upon the birds in the neighborhood? Study the pictures and life of the wild-cat, panther, and leopard. The study of the cat is indispensable as a preparation for the study of wild animals of the cat tribe.

SPRING PLANTS.

In the early springtime, when the first green of plants begins to show itself, the children will be interested in digging down into the ground by the roadside or in pastures to find the root-stalks from which the earliest plants spring; as, for example, the plantain, dandelion, wild parsnip, dock, rhubarb, etc. They will be surprised to find what a strong root, well supplied with food for the little plant, lies there in the ground supporting the growth of the earliest spring shoots. It will be worth the while to take the trouble to dig down into the ground a foot or more to find the full length of some of these root-stalks like the dandelion and wild parsnip. What effect has the cold and frost of winter upon these food-stalks? Why do they come up first among the spring plants? Can you tell how old they are, or how many years they have been growing in the ground?

Let the children bring in different specimens and compare them together in the class. An excursion should be made with the children for half an hour or more with trowels or with spades. It will be easy to collect half a dozen specimens upon one of these short excursions which will serve for another lesson in the school house. A second excursion along the same line will be a first trip to the woods in springtime to dig up spring beauties, blood root, Solomon's seal, and other plants which show an underground stem. Contrast with these perennial plants those which come from seeds like the corn, bean, pea, and many of our garden plants.

THE MOLE.

One of the common animals for study in the third grade is the common mole which spoils our lawns. How can it manage to live under ground and be comfortable? Why should it prefer the dark, damp earth to the freshness and light of the upper world? Catch a ground mole and, taking him into the yard, see how quickly, when set free, he works his way into the earth. How does he do this? What organs does he use? Observe his use of his snout and fore feet. How difficult it is to pull him out of the ground when once he has gotten firm hold. Examine his legs. How does he manage to dig so rapidly? Note the difference between his front and hind legs and feet. Why this difference? Do his front legs and feet

stand out in the same way from his body as the squirrel's and cat's? Why are they different? Notice his claws and muscles. Why are his front legs so short?

How does he manage to live under ground? What does he eat? Examine the teeth. Put him in a box with earth and see if he will eat vegetables or fish worms and grubs. Can he see distinctly? Examine his eyes. Why are his eyes so small and scarcely noticeable? Describe his house underground. Good accounts of these with diagrams, may be found in several of the books and encyclopedias. He has several entrances to his house which offer means of escape. What does he do in the winter time when the ground is frozen? Where does he raise his young? Do you think that the ground mole is of much service to the gardener or is he rather a hurtful animal doing more damage than good? How can he get away from his enemies? Who are his enemies, and how can they capture him? Sometimes at night he comes above the surface and is captured by owls that pounce down upon him. Compare the ground mole with the ground squirrel or gopher. Notice the difference in their teeth, in their food, and in their manner of life. Compare him also with the rat and squirrel.

TOPICS FOR FOURTH GRADE.

FALL TERM.

POND LIFE IN THE FALL.

Dragon flies. Giant water bugs. Mosquitoes.

"Insect Life." Comstock. Chap. IV on "Pond Life" is exactly the kind of a treatment desired for the teacher.

"Handbook of Nature Study." Lange. pp. 17-37.

"Insect Life." Comstock. 131-136.

"School Zoology." Burnet. 95-98.

Bramford's "Up and Down the Brooks."

Consult the Appendix to Lange's "Handbook of Nature Study" for suggestions in regard to field work.

The study of a topic like pond life should extend through the season. It furnishes great variety of material, as water, insects, water birds, water plants, trees, and fishes. It is a simple illustration of a life group changing from season to season and yet having certain strong characteristics, different from other groups.

See also "Recreations in Botany." Creevey.

Chapter IX. "Aquatic Plants." Published by Harper Brothers.

THE BUTTERPRINT, COCKLE-BURR, MILK-WEED, AND OTHER FALL WEEDS.

Study of pods and scattering of seeds.

"Handbook of Nature Study." Lange. pp. 195-199 and 58-69.

The number and variety of seed-pods found among the fall weeds are of much interest. Let

the children bring in specimens. On excursions with the class to near places notice the abundance of seeds with which the above plants are supplied and how they scatter them.

"Recreations in Botany." Creevey.
Chapter XVIII. "Seeds and Fruits."

FALL OBSERVATION OF PLANTS AND TREES STUDIED IN THE SPRING.

Wild flowers, maples, and birches, grape vine, apple tree, seedlings. Continue also the bird calendar. Notice the changes of growth in trees and large plants and vines that have taken place during the summer months.

For the summer months consult

Lange's "Handbook of Nature Study." Chapters IV V, and VI. pp. 44-71.

THE FERNS.

"Glimpses of the Plant World." Bergen. pp. 58-66.
"Elementary Biology." Boyer. p. 140.
"Handbook of Nature Study." Lange. pp. 239-244.
"Little Flower People." Hale. pp. 66-78.
"Recreations in Botany." Creevey. Chapter XII.

Children should collect and replant specimens obtained from their excursions to woods. Study stems and leaves and compare with the tree-ferns of the hot-house and of tropical lands. Observe modes of propagation. Compare with the compound leaves of locust, sumac, and others.

THE MORNING GLORY.

This is for full and prolonged examination. Compare, also, with other climbing plants.

"How Plants Grow." Gray. pp. 10-17.
"A Few Familiar Flowers." Morley. pp. 1-104.
"How to Study Plants." Wood. pp. 182-188.

Mrs. Morley's book contains half a dozen topics on plants completely worked out and will be of great aid to intermediate teachers. Take the children to see the vines and flowers and supply plenty of material for observation. It is easily obtained. Notice the insects that frequent the blossoms.

THE GOLDENROD.

Stem, root, and flowers. A forest of goldenrod. Insect visitors. Bees, moths, butterflies, and beetles. Tenants in and upon the goldenrod.

See "Outdoor Studies." Needham. pp. 29-46. An excellent study.

Review in this study the compound flowers of the previous fall.

"Recreations in Botany." Creevey. Chapter VII.
"Nature Study in Elementary Schools." Wilson. p. 28.

THE FOREST IN THE FALL.

The oak
The hickory.
The walnut.
The maple.

"Trees of the Northern U. S." Apgar. Chaps. I to IV.
"Familiar Trees and Their Leaves." Matthews. pp. 143-171; also, pp. 219-237.

"A Reader in Botany." Newell. pp. 72-83.

"Handbook of Nature Study." Lange. 127-137.

Review the blossoming of trees in spring.

"Stories of the Trees." Mrs. Dyson.

THE OWL, THE HAWK, AND THE EAGLE.

"Birds of Village and Field." Florence A. Merriam. pp. 287-294.

"Handbook of Nature Study." Lange. pp. 268-273.

"Bird Life." Chapman. pp. 116-132.

"Inmates of My House and Garden." Brightwen. pp. 75-82.

"In Birdland." Keyser. pp. 135-140.

Apgar's "Birds of the U. S." for general reference and a manual for identification.

The birds of prey are striking examples of adaptation of organs to use, as the beak, talons, eyes, muscles, structure, and feathers. Even the stuffed specimens help greatly to appreciate these points. Recall in pioneer histories the contact of the settlers with wild birds.

"A Naturalist's Rambles About Home." Abbott. "Owls," chapter XXV.

THE OX, AND BUFFALO, AND DEER.

"Handbook of Nature Study." Lange. pp. 101-109; 278-285.

"Animal Life in Sea and on Land." Cooper. pp. 358-367.

The fuller study of the ox, its food, teeth, cud, stomach, and habits in the field should be made the basis of a grouping of all the ruminants. The study of the buffalo and deer must be mostly from pictures, descriptions, and stories of their life in

nature. But with a good basis of experience in the cow and sheep and by contrast with other animals this may be made profitable and scientific.

THE BAT.

"Longman's Object Lessons." pp. 199-201.
"Handbook of Nature Study." Lange. pp. 76-78.
"Zoological Sketches." Oswald. Chapter V, p. 114.

Specimens may be secured for study in almost any locality. The striking features of elongated and webbed wings are of special interest. The combination of bird and mouse is at once noticed and the peculiar adaptation of wings, teeth, claws, and the folding of the parts should be closely observed. Compare, also, with the webbed feet of birds, the wings of flying squirrels, the wings of chickens and birds. Notice the teeth and food.

THE BLACKBIRD.—(Continued.)

The collection, migrations of blackbirds in the fall, in flocks. Their roosting places; their flight into the fields for food at daybreak and return at evening. Their final departure for the south.

"Handbook of Nature Study." Lange. pp. 29-32.
"In Birdland." Keyser. pp. 64-86.
"Bird Life." Chapman. pp. 48-61, and 170-172.
"Nature Study for Elementary Grades." Wilson. pp. 190-193.
"News from the Birds." Keyser. pp. 138-149.
"A Naturalist's Rambles About Home." Abbott. Chapter XIII.
"Bird Ways." Miller. pp. 93-109.

THE COTTON PLANT.

Show specimens of the cotton boll, seeds and fibre. Cotton clothing, its kinds and uses. Compare it with woolen clothing.

See "A Reader in Botany." Newell. pp. 12-23.
"The Plant World." Vincent. pp. 198-200.
"Lessons on Elementary Science." Salmon. pp. 113-114

WINTER TERM.

HARDWOOD TREES IN WINTER.

"Trees of the Northern U. S." Apgar. pp. 29-34.
"A Reader in Botany." Newell. pp. 72-83.
"Handbook of Nature Study." Lange. pp. 127-137.
"Stories of the Trees." Mrs. Dyson. Chapters I, II, III, X, and XIII.
"Familiar Trees and Their Leaves." Mathews. pp. 219-237.
"The Oak." Ward.

Notice the condition of trees in winter. Preparations for the next year. Make an excursion to the woods in winter to identify trees by bark, trunk, branching, twigs, and location.

COAL AND ITS FORMATION.

"Coal and Coal Mines." Homer Green.
"The Story of a Piece of Coal." Martin.
"First Book in Geology." Shaler. pp. 46-55.
"Lessons on Elementary Science." Salmon. pp. 136-138.
"The Fairy Land of Science." Buckley. Lecture VIII. pp. 171-192.
"Town Geology." Kingsley. Chap. 4. pp. 117-160.
The Earth and Its Story." Heilprin. pp. 226-230.

Bring in specimens of fossil leaves and plants embedded in the coal. Locate the place of the coal measures in geological history. Describe the process of coal formation. Connect with the lessons on the coal mine in geography.

FRESH AIR AND VENTILATION.

Let this be treated as a house topic. Use the ventilation of the school room as an illustration The constituents of the air, oxygen, nitrogen, and carbonic acid.

"Lessons on Elementary Science." Salmon. 138-140.
"Applied Physiology." Overton. pp. 92-103.

The hygiene of fresh air.

The lungs and fresh air. Changes in the lungs in breathing.

See Blaisdell's "How to Keep Well." Chapter VIII.

THE EVERGREEN FOREST.

Scotch pine, hemlock, arbor vitae, southern pine, red wood, forests of the north and south.

See "Stories of the Trees." Mrs. Dyson. Chapters XX-XXI.

"The White Pine." Pindert & Graves. A small book published by the Century Co.

"Recreations in Botany." Creevey. Chapter X.

Examine the clusters of evergreens in the neighborhood. Notice the withering of the lower limbs.

The rookeries for crows and winter birds.

Describe the northern pineries and contrast with hard wood forests.

WATER.

Solid, liquid, and gaseous forms. Evaporation. Water as a solvent. Vapor, steam. Life in water. Springs and under-ground water.

"One Hundred Lessons in Nature Study." Payne. pp. 106-8.

"The Fairy Land of Science." Buckley. Lecture IV. pp. 72-98.

"The Great World's Farm." Gaye. Chapter VIII. pp. 90-104. Seeley & Co.

"The World of Matter." Ballard. Chapters I-IV. D. C. Heath & Co.

Pure water for drinking. Surface contaminations. How pure water is obtained. Filtering. Distilling.

IRON.

Ore. Qualities of pure iron. Kinds of iron. Steel. Qualities of steel. Collect specimens.

"Nature Study." Payne. pp. 126-7.

"The World of Matter." Ballard. Chapter XVIII. pp. 165-170.

"The Earth and its Story." Heilprin. pp. 215-220.

Heat iron and show its qualities.

Compare with lead already studied.

Rusting of iron.

Various uses of iron.

Call to mind the blast furnace from the geography studies and the manner of making pig iron, its uses, etc.

KINDS OF ROCKS.

Pebbles, fossils, shells.

"Guides for Science Teaching." Hyatt. No. XII. and No. I.

"Nature Study in Elementary Schools." Wilson. pp. 177-183.

Bring in specimens of lime stone, sand stone, pebbles, flint, granite, marble, slate, and tell where they come from.

Notice the action of the weather upon lime stones, marbles, and other building stone.

See, also, "Nature Study in Elementary Schools." Wilson. pp. 254-256.

THE BLUE JAY.

The blue jay is one of the most common and interesting of our winter birds and can be watched, or at least occasionally observed in winter.

"Handbook of Nature Study." Lange. pp. 265-6.

"Inmates of my House and Garden," by Brightwen. pp. 105-113.

"Birds Through an Opera Glass." Merriam. pp. 69-75

THERMOMETER AND BAROMETER.

Work upon thermometers and barometers should be illustrated by experiment. Children should learn to read understandingly these instruments. This topic is closely connected with the topic of temperature, heat, and cold.

"Elementary Meteorology." Waldo. pp. 31-42.

"Longman's Object Lessons." Salmon. pp. 174-178.

HYACINTH, LATE WINTER.

See Margaret Morley's "A Few Familiar Flowers." This is a very suitable study for late winter. Get the bulbs.

"Nature Study in Elementary Schools." Wilson. pp. 96-98.

Compare with the onion and tulip.

Keep specimens growing in the school windows and later in spring transplant to school garden.

SPONGES.

Specimens of different kinds of sponges should be examined in the class, and pictures, descriptions of sponge fisheries should be examined.

"Guide for Science Teaching." Hyatt. No. III.

"Animal Life in Sea and on Land." Cooper. pp. 1-11.

"Living Creatures of Water, Land, and Air." Monteith. pp. 11-17.

THE MUSKRAT AND BEAVER.

Muskrat houses. Examine the muskrat to see if he is fitted for life in the water. Notice feet and fur, teeth and food. How is he caught by trappers? Feel of the pelt and see if it is valuable as fur.

Describe the home and habits of the beaver. Notice also the teeth and their use as compared with the squirrel, rabbit, rat, mouse.

"Animal Life in Sea and on Land." Cooper. pp. 387-390.

"Lessons on Elementary Science." Salmon. pp. 104-107.

"A Naturalist's Rambles About Home." Abbott. Chapter X

SPRING TERM.

WILD DUCK AND WILD GOOSE.

The study of the wild duck and the wild goose as types of water birds is one of the best chances for noticing the adaptation of organs to a peculiar mode of life. The use of the feathers and down, the webbed feet, flat bill, the shape of the body, the muscles, and bony structures at every point show marvelous adaptation. The contrast with other kinds of birds, as the perchers and warblers, will bring out more plainly this peculiar fitness for water life.

"Bird Life." Chapman. pp. 92-94.

WOOD-FLOWERS IN SPRING.

THE SPRING BEAUTY.

"How to Study Plants." Wood. pp. 39-44, 60-64, 229-232, 246-249.

"Handbook of Nature Study." Lange. p. 153.

"Nature Study in Elementary Schools." pp. 229-235.

Excursions to the woods for specimens of spring beauty, jack-in-the-pulpit, bloodroot, hepatica, violets, Solomon's seal, etc., should be made. If taken up with the dirt, the roots and tubers can be observed or they may be transplanted into the school garden.

SPRING BIRDS.

Catbird, brown thrush, the meadow-lark and the quail, and the bobolink.

Observe the birds along the hedges and in the meadows, their song, colors, nests.

"Birds Through an Opera Glass." Merriam. pp. 40-42.
"Birds of Village and Field." Merriam. p. 37.

INSECT LIFE IN THE ORCHARD.

The orchard furnishes a good life group for study in the springtime. Notice the insects upon grass and trees. Also the birds. The insects visiting the blossoms.

Observe the eggs and larvae of one of the apple tree moths as it develops. Compare it with the butterfly.

An excellent series of studies upon orchard insects is given in:

"Insect Life," by Comstock. Chapter VI. pp. 166-185.

The following chapter treats of forest life in a similar way.

MUSHROOMS.

"Glimpses of the Plant World." Bergen. Chapter IV.
"Hand Book of Nature Study." Lange. pp. 248-250.

Collect specimens and notice their structure. Observe where they grow and when they spring up. Have they roots? Do they come from seeds? Observe also the colors, sizes, and length of life. Learn to distinguish between the poisonous and edible mushrooms.

THE BUTTERFLY.

"Frail Children of the Air." Samuel Hubbard Scudder.

"Handbook of Nature Study." Lange. pp. 199-204.

"Elementary Lessons in Zoology." Needham. pp. 36-42 and 86-93.

"Insect Life." Comstock. pp. 245-254.

"Living Creatures in Water, Land, and Air. Monteith. pp. 108-112.

"Boys and Girls in Biology." Stevenson. pp. 184-186.

"School Zoology." Burnet. pp. 101-106.

Scudder's "The Milkweed Butterfly." Henry Holt & Co. Whole book.

Study the life history of one or two butterflies. Make collections. Work out the chief stages of the metamorphosis. Compare with grasshopper, mosquito, dragonfly, and other insects previously studied.

CLOUDS AND RAIN.

"Elementary Meteorology." Waldo. pp. 118-124 and 142-146.

"Nature Study in Elementary Schools." Wilson. pp. 153-155.

"Lessons on Elementary Science." Salmon. pp. 141-142.

"Elementary Lessons in Physical Geography." Geikie. Chapter II. pp. 38-83.

"The Story of the Atmosphere." Douglas Archibald. Chapters VII and VIII. pp. 108-24.

"The Ocean of Air." Giberne. Part III. pp. 155-208.

Study causes of dew, clouds, rain, evaporation, and condensation.

See also "Elementary Lessons in Physical Geography." Geikie. Lesson X. pp. 64-102.

TOBACCO.

The tobacco plant.

The use of tobacco and its evil effects, especially upon the young. Nicotine.

History of the use of tobacco.

"Applied Physiology." Overton. pp. 44-48.

"Lesson on Elementary Science." Salmon. pp. 124-125.

Connect with the geography lessons on tobacco.

AN AQUARIUM AND FISHES—SUN FISH, PERCH, BASS, ETC.

How to keep an aquarium.

"Nature Studies for Elementary Schools." Wilson. pp. 116-121.

Let the children observe and find out how to take care of fishes, food, kind of water, organs, as fins, gills, and eyes. Movements of the fish in water. Their eggs and young.

"Elementary Biology." Boyer. p. 53-68.

"Longman's "Object Lessons." pp. 204-5.

"Handbook of Nature Study." Lange. 295-298.

"Elementary Lessons in Zoology." Needham. pp. 160-178.

"School Zoology." Burnet. 136-144.

"Nature Study." Payne. pp. 81-85.

The following list for third and fourth grades consists of larger and more expensive books than those given in the introduction to the third grade; but they are excellent books for the teacher and for teachers' libraries.

"Insect Life." An introduction to nature study, by John Henry Comstock. D. Appleton & Co.

"Birds of Village and Field." A book for beginners, by Florence A. Merriam. Houghton, Mifflin & Co.

"In Birdland." Keyser. A. C. McClurg & Co.

"Bird Life." A guide to the study of our common birds, by Frank M. Chapman. D. Appleton & Co.

"Familiar Trees and Their Leaves." F. Schuyler Matthews. D. Appleton & Co.

"The Ocean of Air." Agnes Giberne. Educational Publishing Co.

"Frail Children of the Air." Samuel Hubbard Scudder. Houghton, Mifflin & Co.

"Butterflies." Their structure, changes, and life histories, by Samuel H. Scudder. Henry Holt & Co.

"Inmates of My House & Garden." Mrs. Brightwen. The Macmillan Co.

"Romance of the Insect World." L. N. Badenoch. The Macmillan Co.

"News From the Birds." Keyser. D. Appleton & Co.

"Animal life in the Sea and on the Land." Cooper. American Book Co.

"Recreations in Botany." C. Creevey. Harper Brothers.

"The Stories of the Trees." Mrs. Dyson. Thomas Nelson & Sons.

"The Oak." Ward. D. Appleton & Co.

"The Fairy-Land of Science." Buckley. D. Appleton & Co.

"A Naturalist's Rambles About Home." Abbott. D. Appleton & Co.

"Elementary Biology." Boyer. D. C. Heath & Co.

Most of the publishing companies have offices in Chicago, except Thomas Nelson & Sons, N. Y.; Harper Brothers, N. Y.; Longmans, Green & Co., N. Y. Any of these books can be ordered from The Public School Publishing Company, Bloomington, Ill.

McMurry's Books for Teachers.

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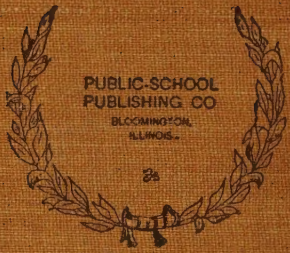
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